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The Journal of Infectious Diseases

PUBLISHED BY THE MEMORIAL INSTITUTE FOR INFECTIOUS DISEASES

VOL. II

September 1912

No. 2

IS TYPHOID FEVER A "RURAL" DISEASE?*

WILLIAM T. SEDGWICK,
Professor of Biology and Public Health, Massachusetts Institute of Technology.

GEORGE RODNEY TAYLOR,
Chemist and Bacteriologist, Gas and Water Company, Scranton, Pa.

J. SCOTT MACNUTT,
Health Officer, Orange, New Jersey, and Sometime Assistant to the Pittsburgh Typhoid
Fever Commission.

(From the Sanitary Research Laboratories, Massachusetts Institute of Technology, Boston.)

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I. INTRODUCTION.

There has long been a widespread belief that typhoid fever is a "rural" disease, i.e., a disease having its natural habitat in the country. On the other hand, bacteriology and epidemiology have proved that typhoid fever is a disease of contact, of crowding, and

* Received for publication May 2, 1912.

of infected food and drink—conditions far more common in city than in country. Obviously, so sharp a contradiction between a condition reputed to exist, and a condition required by theory, calls for careful investigation.

Paragraphs in the newspapers and magazines often advise persons about to visit the country to beware of typhoid infection, implying if not affirming that the dangers of such infection are greater in the country than in the city. And when the annual autumnal excess of typhoid fever, which occurs almost everywhere in northern latitudes, draws attention to this disease, it is frequently asserted, not only by newspaper and magazine writers, but also by medical men—and sometimes even by sanitarians—that this excess is due to the fact that many city dwellers have recently returned from vacations in the country, and have brought with them either typhoid fever or the germs of typhoid fever.

This explanation of some cases of autumnal typhoid is so obviously true that the forbidding term “vacation typhoid” has been coined and widely circulated and is now often accepted at its face value, even by persons who have given attention to the causation of typhoid fever, as satisfactorily accounting for most of the regular autumnal excess of that disease. This modern notion of “vacation” typhoid, moreover, is closely connected with an older theory that typhoid fever is pre-eminently a “rural” disease, a doctrine long maintained on good grounds by excellent authorities and powerfully supported by theories—such as Murchison’s pythogenic theory—of the spontaneous origin of fevers like typhoid in manure-heaps, decaying organic matters, and filth of various kinds.

The rise of bacteriology and the decade of the great pathological discoveries have, however, disproved Murchison’s and similar theories, and the simple faith of a former generation in filth and “fomites” as birthplaces for disease germs has been proved to be groundless. Meantime, the importance of contact, of carriers, of crowding, of promiscuity, and of public supplies of all sorts as sources and vehicles of infection, and the value of isolation of persons and supplies and of the absence of contact, of crowding, and of promiscuity as safeguards against infection have become generally admitted and recognized, until it is today almost impos-

sible to believe that the dangers of infection in the sparsely settled country are anywhere near as great as in the crowded city, or *a fortiori* that typhoid fever is today really a "rural" disease. This fact is strengthened and supported by considerations of bacteriology and epidemiology, for it is today impossible to believe that the germs of typhoid fever which must pass from person to person by contact or in food or drink, can be as widely or as effectively distributed by isolated carriers, isolated wells, or isolated milk supplies in rural districts, as by the city carrier necessarily coming into contact with far more people, or the public water or milk supply of the city, reaching as it does simultaneously hundreds or thousands, instead of units or tens or twenties.

And yet it is still often affirmed that "typhoid fever is a rural disease" and implied if not stated that city people who spend vacations in the country are more liable to contract typhoid fever there than they would be if they stayed in the city. We have here therefore, as already said, a flat contradiction between conditions reputed to exist and conditions according to modern ideas to be expected; and it is this contradiction which has seemed to us to require explanation, and has induced us to examine into the facts and to prepare the present paper.

The question at issue is simply *whether, in proportion to the population, typhoid fever is more prevalent over rural or over urban areas*; and for an answer we have turned to the mortality statistics of Massachusetts as a state having trustworthy records and one with which we are personally familiar. These statistics we have examined from various points of view with special reference to the question at issue. For control, we have made a similar though less minute study of the mortality statistics of a more rural contiguous state, New Hampshire, as well as those of Connecticut, another contiguous state which for various reasons is also instructive in this connection. Brief references have likewise been made to the mortality statistics of foreign countries, such as England and Wales, Scotland, and Germany.

Before presenting the methods and results of our statistical studies, we shall consider at some length the rise and the present state of opinion relating to typhoid fever as a rural disease; and in

another section, also in some detail, the common employment of the terms "rural" and "urban," as well as their true sanitary significance and proper scientific usage.

2. STUDIES AND STATEMENTS OF PREVIOUS WRITERS.

As far as we are aware, the earliest statistical study which led to the conclusion that typhoid fever is a rural disease was made by Dr. George Derby, secretary of the then newly organized State Board of Health of Massachusetts, and published in the Report of that Board for 1871. Dr. Derby's paper is entitled "The Causes of Typhoid Fever in Massachusetts" and is an elaborate statistical research covering the decennium, 1859-68. Dr. Derby's studies were based upon the mortality statistics of typhoid fever in all the "towns" of Massachusetts for that period. Because of the fundamental character of this paper, and the probability that from it has very largely come the present doctrine of typhoid fever as a rural disease, we shall quote from it somewhat freely:

"The first thing which strikes us on looking over this table is the apparently greater mortality from typhoid in the small towns. How great this difference is will appear from the following comparison:

TABLE SHOWING RELATIVE MORTALITY FOR TEN YEARS FROM TYPHOID FEVER
IN PERSONS ABOVE FIVE YEARS OF AGE, IN THE LARGER
AND SMALLER CITIES AND TOWNS.

	Population 1865 (All Ages)	Total Deaths from Typhoid in 10 Years	Average Number Persons Living Each Year to One Death	Average Number Deaths Each Year to 1,000 Persons Living
147 cities and towns of more than 2,000 inhabitants.	1,044,294	7,888	1,323.90	0.755
184 towns of less than 2,000 inhabitants..	213,468	2,539	840.75	1.189

"There can be no doubt that typhoid in Massachusetts is a disease of scattered communities rather than of crowded towns, of rural rather than of urban districts. In spite of the smaller mortality from all causes, typhoid is more destructive in the farming towns than in the manufacturing towns and the large cities" (pp. 118, 119).

Again, later in the same paper:

"Everyone familiar with the state knows that there is a very large number of towns with a population of from five to ten thousand, compactly built, with no water-supply except from wells, and no means of disposing of excrement except by privies, and we know from the registration returns that the people of these towns are more free from the pest of typhoid in proportion to population than the inhabitants of agricultural districts" (p. 166).

Again, from the letter of a Boston correspondent:

"A very considerable number of the cases of typhoid treated in Boston during the autumn originates in the country and at seaside places where families from the city have passed the summer" (p. 128).

This able and thorough study thus arrives at a definite conclusion that typhoid fever is chiefly a disease of communities of less than 2,000 inhabitants. Here is apparently one of the main sources of the "rural typhoid" doctrine.

The next study of the kind, so far as we have been able to discover, was a thorough and detailed statistical research, published by Dr. Samuel W. Abbott in the Report of the State Board of Health of Massachusetts for 1891, as a part of a paper on "The Geographical Distribution of Certain Causes of Death in Massachusetts." The first part of the section on typhoid fever, which covers the twenty-year period, 1871-90, deals with the relation of prevalence to density of population, by counties. The following summary table is an abridgment of that given on p. 822 of the report.

Counties Grouped According to Their Density of Population	Average Acres to Each Person	Mortality Rank from Typhoid Fever. The State = 100
I. County in which there is less than one acre to each inhabitant.....	0.07	91
II. Counties (5) having more than one but less than four acres to each inhabitant.....	2.10	101
III. Counties (8) having more than four acres to each inhabitant.....	6.40	107

Dr. Abbott concludes from this table that:

"The mortality from typhoid fever does not depend upon the density of population as the principal favoring condition for its spread. The most densely settled metropolitan district had a comparatively low mortality rate from this cause, while the group of sparsely settled counties had an average high ratio of mortality from typhoid fever. . . ."

"Estimating the mortality of the densely settled districts as 1,000, the mortality of these three groups from typhoid fever was as follows:

The *dense* districts.....1,000
 The *medium* districts.....1,109
 The *sparse* districts.....1,175

The analysis thus summarized has apparently furnished a basis for the doctrine that typhoid fever is chiefly a rural disease, because it is here shown, under the conditions considered, to be more prevalent in the *sparsely* settled counties. But while density studies

applied to small areas—as those of a New England “town”—may be reliable, the results from the comparatively large areas of counties are, in the light of the considerations presented in section 3 of this paper, open to serious criticism. In the county all grades of urban and rural life are included and merged together and *general* density figures cannot give any adequate indication of that local distribution of population which is the *sine qua non* of a study of urban vs. rural conditions.

Dr. Abbott, however, later in his study, does take up the separate towns considered with reference to density of population, and this mode of attack we believe to be much more effective than that just quoted. He bases his observations upon a table, similar to the one presented by Dr. Derby for 1859–68 in which the towns of Massachusetts are arranged according to their typhoid death-rates.

“An examination of the extremes reveals no very striking characteristics. But one town, Gosnold (the smallest in population), had no deaths from typhoid fever during the twenty years. This town comprises the Elizabeth Islands, lying at the mouth of Buzzard’s Bay. Its population in 1880 was 152.

“The twenty towns having the lowest rank in the list are scattered throughout the state in ten of the counties, and, with the exception of one of the smaller cities (Waltham), are small towns. Twelve of this number had less than 1,000 inhabitants in each in 1880. There does not appear to be any point of special significance relative to these twenty towns.

“Of the twenty towns which hold the highest position upon the list, seventeen are in the four western counties and the western border of Worcester County. Dalton, with the highest ratio, is a manufacturing town (paper mills) among the Berkshire Hills, lying at an elevation of more than 1,000 feet above the sea-level. Ware, Brookfield, Great Barrington, and Westfield are also manufacturing towns of western Massachusetts. Ten of the remaining towns are small agricultural towns, having a population in each of less than 1,000, and their position may hence be regarded as having but little significance.

“The city of Holyoke, which had 498 deaths from typhoid fever in the twenty-year period, and ranked 203 in this list as compared with the state (100), is a manufacturing city of rapid growth. Its population in 1870 was 10,733; in 1880, 21,915, and in 1890, 35,637. The principal industry is the manufacture of paper” (p. 823).

A classification of towns by density of population is thus described:

“For the purpose of making a more intelligent classification I have therefore classified the towns into two general divisions of manufacturing or densely settled towns, and agricultural or sparsely settled towns.

“The former embraces 87 municipalities, including all the 28 cities. None of

this number had less than 2,000 inhabitants in each, and only 10 had less than 4,000; and each of these smaller towns had one or more villages having a comparatively dense population living in a district of limited size. The average population of each municipality in this group by the census of 1880 was 15,434. Most of them have a steadily increasing population, a large proportion of which consists of immigrants, either of European nativity or from the British North American provinces. In many of the towns of this class there is a rural population of considerable size living in those portions outside the more densely settled villages. The actual increase in population in the rural towns, for the period of twenty years, between the census of 1870 and that of 1890, a period nearly coincident with that under consideration, was 11½ per cent, while that of the larger or manufacturing and urban districts was 70 per cent.

"The other group, of agricultural towns, 259 in number, has but few towns having 3,000 in each, and the average population of each in 1880 was 1,700. Their population is distributed over an average area of nearly 30 square miles for each township. The principal occupation of the people of these towns consists of dairy farming, market gardening, and other branches of agriculture. A few of these towns are summer resorts, either upon the sea-coast or in the inland region. Some of the towns of this general class have increased slightly in population in the past twenty-five years, many have remained stationary, and a considerable number have slowly decreased. . . . The population of the first group in 1880 was 1,342,782, and that of the second group, 440,303" (pp. 762-63).

"Dividing the towns into [this] more accurate classification, without regard to county lines, the towns which may be considered as having a dense population had a mortality rate of 5.15 per 10,000 annually from typhoid fever, while the remaining towns had a mortality rate of 5.54 per 10,000" (p. 823).

This finding, based as it is upon much smaller areas than the counties, approaches much more nearly the study of purely local conditions which alone is instructive for our present purpose, and should therefore be accorded much greater weight.

Dr. Abbott has later stated that it is among that portion of the population not supplied with public water that "typhoid fever largely occurs."¹

Finally, Dr. Abbott compared the mortality in towns, with the results obtained by Dr. Derby for 1859-68, finding that the same general relations between urban and rural—manufacturing and agricultural—communities still held good in the later period. There is, however, one important difference, viz.:

"The cities which had specially high death-rates from typhoid fever in the later period (1871-90)—Holyoke, Lowell, Lawrence, Fall River and Chicopee—held an intermediate position in 1859-68; and it was not until after a polluted water-supply had been introduced in Lowell and Lawrence that their death-rate from typhoid fever reached an unusually high figure."

¹ Reference Handbook of the Medical Sciences, 1904, 8, p. 254.

The researches of others which we shall summarize are based upon arbitrary statistical divisions of communities into two crude groups of "urban" and "rural." The next in point of time that we have been able to discover is that of Ernst Bolin, based upon the official statistics of Sweden and published at Stockholm in 1893 as a Doctor's thesis presented to the medical faculty of Upsala University, entitled *Tyfoidfiebern i Sverige*. The author gives for *närv-* and *hjärnfieber* taken together (equivalent to typhoid fever) the following figures:

	DEATH-RATES PER 100,000 OF POPULATION		
	Towns*	Country Villages†	Whole Kingdom
1876-1880.....	53	31	34
1881-1885.....	34	26	27
1886-1890.....	24	22	23
1876-1890.....	36	26	28

* The *towns* (*städer*) are distinguished in the official statistics as a separate group. According to the Census of December 31, 1890, there were at that time 92 *städer* with an aggregate population of 899,698. Of these 10 had populations of less than 1,000; and 21 between 1,000 and 2,000. It is obvious that the proportion of the total population contributed by these towns of less than 2,000 is inconsiderable (about 5 per cent), and for present purposes the Towns group may be taken to represent places of over 2,000 population.

† The *country villages* (*landsbygden*), though including a few places of over 2,000, practically represent rural communities of less than that figure, since the population of the few larger places is relatively very small. "Among the places which are not, in law, recognized as towns, there are a few which have a total population of more than 2,000 souls. Some of these places are suburbs of towns; . . . others are what are called *köpingar* (boroughs), which, from a legal point of view, are something between town and country and, finally, there are some industrial and business places, of which Malmberget . . . and Trollhattan, with 7,000 inhabitants each, are about the largest" (*Sweden, Its People and Its Industry*, pub. by order of the Swedish Government, 1904, p. 103). The rural region or *landsbygden* comprised in 1890, 3,885,283 inhabitants, including 20 *köpingar* (boroughs). Of the latter, 12 were under 1,000 and 6 from 1,000 to 2,000; the remaining two having 2,205 and 2,075. Thus it is evident that the rural character—as assumed for small communities—of the country villages group is not seriously altered by the inclusion of the few places of over 2,000 population.

Taking *närvfieber* alone (as the term *hjärnfieber* is subject to inexactness), the figures are as follows (p. 56):

	DEATH-RATES PER 100,000 OF POPULATION		
	Towns	Country Villages	Whole Kingdom
1876-1880.....	52	25	29
1881-1885.....	32	25	27
1886-1890.....	23	22	22
1876-1890.....	34	24	26

The conclusion is reached that:

"Typhoid fever, for the entire period, 1876-90, was more general in the towns than in the country villages" (p. 58).

The same conclusion is reached when the proportion of typhoid deaths to the whole number of deaths from all causes is considered (p. 62).

The division here is at a population of 2,000. How far places in Sweden of less than this number of inhabitants represent typical rural conditions we cannot presume to say. The higher group of "towns" is probably a heterogeneous mixture of urban and rural.

To return to American studies, Dr. F. C. Curtis published in the Bulletin of the New York State Department of Health, October, 1900, a statistical study on the distribution and etiology of typhoid fever in that state. Though it was not the object of his study to draw conclusions as to urban and rural typhoid, data are given of 20 of the largest cities in New York state, and, by contrast, of small rural towns, the communities falling between these two groups being omitted. The following is an abstract of the principal table presented:

AVERAGE DEATH-RATE FROM TYPHOID FEVER, 1890-1899, IN 20 CITIES OF 20,000 AND OVER POPULATION.

Low Prevalence	Rate per 100,000 Population
New York.....	17.0
Yonkers.....	16.0
Kingston.....	20.0
Utica.....	20.0
Auburn.....	25.0
Rochester.....	26.0
Moderate Prevalence	
Oswego.....	27.0
Buffalo.....	31.0
Syracuse.....	35.0
Newburgh.....	37.0
Excessive Prevalence	
Poughkeepsie.....	42.0
Amsterdam.....	52.0
Binghamton.....	52.0
Troy.....	55.0
Elmira.....	55.0
Very High Prevalence	
Watertown.....	80.0
Niagara Falls.....	80.0
Albany.....	86.0
Cohoes.....	90.0
Schenectady.....	100.0
Rural towns (800).....	23.0

The "rural towns" mentioned at the end of this table appear to be a group of the smallest communities arbitrarily set apart after the cities, villages, and more populous towns are taken out. The group is thus fairly representative of the small agricultural villages and hamlets, as well as of the purely agricultural regions. There is no exact criterion of population, but, to judge from other statistical tables of the Bulletin, very few of the communities are over 2,000, while all places under that figure are included. The indication is that genuinely agricultural or rural conditions characterize this group, which has a typhoid death-rate below all but four of the large cities. Dr. Curtis comments on the table as follows:

"Some zymotic diseases belong especially to the cities; evidently typhoid fever does not of necessity. The maritime district is almost wholly urban and its annual death-rate of 17.0 and ratio of 0.86 per cent of total mortality is the lowest; and including more than half the entire population reduces the state death-rate to 24.0, which without it would be 31.0. Neither is it on the average a disease of high mortality in rural towns, for they have a constant mortality of from 22.0 to 25.0 per 100,000 population, and districts with the smallest so-called urban population approach nearest to the rural rate" (*Ann. Rpt. N.Y. State Bd. of Health*, New York, 1900, pp. 429-30; also in Bulletin for October, 1900).

The comparison here made between large cities and small "rural towns" we believe to be valuable, so far as it goes. It is to be noted that the indication of these statistics that the "rural towns" are comparatively low in typhoid is the reverse of the conclusions arrived at by Drs. Derby and Abbott in Massachusetts.

The following extracts indicate the statistical analyses—based upon a division of communities into "urban" and "rural," above and below the 8,000 population mark respectively—published by the U.S. Census since 1890. The misleading character of this mode of division, which will be discussed in section 3, must be borne in mind.

"Typhoid fever was slightly higher in 1900 in the rural districts (25.5) than in the cities (25.3), which is the reverse of the case in 1890, when the rate in the cities was 39, and that in the rural districts 31.4" (*Census of 1900*, 3, p. cxlv).

	NUMBER OF DEATHS FROM TYPHOID FEVER PER 100,000 OF POPULATION					
	Annual Average	1900 to 1904				
		1900	1901	1902	1903	1904
Cities in registration states.	25.8	28.5	26.5	25.9	24.6	24.0
Rural part of registration states	27.8	34.6	28.8	27.0	24.7	23.8

(Mortality, 1900 to 1904, excerpted from table on p. xxi.)

"Comparing the rural and urban districts of the registration states it will be seen that the mortality from typhoid fever was greater in the rural districts than in the cities in each year except 1904, in which it was very slightly greater in the cities" (*ibid.*, p. xxii).

In the *U.S. Mortality Statistics* for 1907 the typhoid fever rates per 100,000 for 1906 and 1907 are given as follows:

	1906	1907
Cities in registration states.....	34.2	31.7
Rural part of registration states.....	28.6	26.0

Among the most detailed studies on rural typhoid which we have found is that contained in a paper by Dr. John S. Fulton, published in the Report of the State Board of Health of Maryland for 1903, and entitled "Typhoid Fever: Some Unconsidered Hindrances in Its Prophylaxis." This research is probably the most thorough and authoritative hitherto made. It is, however, unfortunately based almost entirely upon the arbitrary and (for this purpose) misleading classification of the U.S. Census, and the real question of rural typhoid fever, accurately speaking, is hardly touched upon by any portion of the study. We shall briefly summarize that portion of the paper in which the question now at stake is taken up, and from p. 61 may quote the following introduction:

"The belief that typhoid fever is more common in close communities, and that its incidence is heaviest in cities, has its place in the medical mind by a sort of common consent. The grounds of the belief have not been examined, if, indeed, they have been stated. The late Colonel George Waring said in 1878: 'Typhoid is peculiarly a disease of the country rather than of the town.' No similar statement, I believe, is made by any American medical author; but the opposite view, that typhoid is peculiarly a disease of cities, is expressed in the most recent editions of at least four American textbooks on medicines.¹

"Typhoid fever makes its most striking demonstrations in cities, and the definite influence of sanitary works on its prevalence has made the typhoid rate the accepted index of municipal hygiene. Typhoid fever has, nevertheless, at the present time and in this country a heavier incidence on small communities and rural districts, and probably this has been the case for a long time; for sanitary works have neither such excellence nor so wide employment in American cities as to give urban populations in general good defense against typhoid. On the contrary, the conditions of American cities with respect to water supply and disposal of waste might be expected to produce a constantly higher typhoid mortality than is experienced under rural conditions."

¹ We have been unable, after a careful search through the textbooks of Osler (1901), J. C. Wilson (1896), H. M. Lyman (1892), William Gilman Thompson (1902), and others, to verify this statement.

The following fields for statistical evidence, based upon the Census division into "urban" and "rural," are then considered in detail: registration area, "grand groups" of the Census, and five "grand groups." The principal result of the study is summarized in the table quoted below and prefaced as follows:

"Some doubt may be admitted as to whether these grand divisions can fairly be compared. If the United States be divided into state groups on the basis of the distribution of the population between town and country, we can eliminate to a great extent the influence of latitude and longitude."

	Average Percentage of Rural Population	Average Typhoid Fever Death-Rate per 100,000
Five states in which the urban population was more than 60 per cent of the total.....	30	25
Six states in which the urban population was between 40 per cent and 60 per cent.....	49	42
Seven states in which the urban population was between 30 per cent and 40 per cent.....	67	38
Eight states in which the urban population was between 20 per cent and 30 per cent.....	75	46
Twelve states in which the urban population was between 10 per cent and 20 per cent.....	87	62
Twelve states in which the urban population was between 0 and 10 per cent.....	95	67

The above groups are constituted as follows, in order: *Five states*: Massachusetts, New York, New Jersey, District of Columbia, Rhode Island. *Six states*: Connecticut, Pennsylvania, Delaware, Maryland, Illinois, California. *Seven states*: New Hampshire, Ohio, Michigan, Wisconsin, Missouri, Colorado, Washington. *Eight states*: Maine, Indiana, Minnesota, Louisiana, Montana, Wyoming, Utah, Oregon; *Twelve states*: Vermont, Virginia, South Carolina, Georgia, Florida, Tennessee, Alabama, Texas, Iowa, Nebraska, Kansas, Kentucky. *Twelve states*: West Virginia, North Carolina, North Dakota, South Dakota, Mississippi, Indian Territory, Oklahoma, Arkansas, New Mexico, Arizona, Nevada, Idaho.¹

"The experience of Maryland supports the general indications of these figures. There is but one large city in the state. The inhabitants of Baltimore are half of the total population of the state. There are but two other towns having as many as 8,000 inhabitants. It may be fairly said that the population of the state is equally

¹ In this part of the study on p. 63 are several misprints or errors. In one case 12 states are mentioned with the names of only 8; in another, 12 states are mentioned with the names of only 11. Several of the figures given do not agree with those given in the statistical tables printed at the close of the paper.

divided between rural and urban conditions. The ratio of typhoid mortality is 1 to 2.5 in favor of Baltimore, a poorly sewered city, supplied with unfiltered water from an extensive and unprotected watershed."

The study closes with a tabulation of the cities of the United States arranged in groups according to population, showing that the typhoid mortality rises somewhat as the populations diminish. But the smallest group given has an average population of over 12,000, so that rural communities are not concerned. A group of almost eight million people remaining over and above the cities, and called 95 per cent rural, shows a higher mortality than any of the city groups.

Dr. Fulton concludes:

"The infection is more heavily seeded in small communities, and the propagation of the disease is in general from the country to the town, rather than from town to country. The explanation of this fact is probably found in the greater care given to the disposal of human excrement as communities grow more populous" (p. 67).

As evidence of the strong persistence of the rural typhoid theory as above elaborated, it is interesting to note that a recent authority, George C. Whipple, cites Dr. Fulton's study with the remarks:

"Contrary to what many people suppose, typhoid fever is more largely a rural disease than an urban disease, meaning by rural small communities in distinction from large communities" (*Typhoid Fever*, New York, 1908, p. 112).

"The autumnal increase of typhoid fever in cities is sometimes referred to as 'vacation typhoid,' the idea being that it is due to patients returning sick from the country. This theory is based on the fact that typhoid fever is at present chiefly a rural disease, and so far as this goes it is correct" (*ibid.*, p. 127).

Mr. Whipple thus concurs in Dr. Fulton's conclusion so far as *distribution* of typhoid fever is concerned. In regard to its *propagation* he goes on to say:

"But the notion of 'vacation typhoid' has been very much overworked, and, as a matter of fact, it does not to any very material extent, account for the summer and autumn increase of typhoid fever in the large cities. In Washington it was estimated that during the summer and autumn of 1906, 85 per cent of the cases were contracted within the city, and studies of imported cases in other cities have given similar figures" (*loc. cit.*).

By way of further comparison, the statistics of the Registrars-General of England and Wales, and of Scotland may appropriately be cited at this point. For Scotland we quote the following mortality figures for typhoid fever since 1899:

DISTRICTS	CONTAINING PLACES HAVING POPULATIONS	ENTERIC DEATH-RATES PER 100,000 POPULATION							
		1900	1901*	1902	1903	1904	1905	1906	1907
Scotland.....	.....	15	16	12	12	9	8	9	8
Principal town districts	More than 30,000...	14	18	11	14	10	7	8	7
Large town districts...	10,000 to 30,000...	19	17	18	15	11	16	17	15
Small town districts...	2,000 to 10,000...	17	18	11	11	8	7	7	6
Mainland rural districts	Under 2,000.....	12	11	11	9	7	5	6	5
Insular rural districts..	Under 2,000.....	10	12	16	11	10	8	11	8

* Census year.

Populations of groups, estimated for 1907, were approximately as follows: principal town districts, 2,178,000; large town, 603,000; small town, 964,000; mainland rural, 919,000; insular rural, 113,000.

The division into "town" and "rural" is made at 2,000 population; and here, as for Sweden, we cannot venture to say whether communities below that figure probably fairly represent rural conditions. The town groups are presumably a mixture of rural and urban, with the latter predominating.

For England and Wales the figures are less detailed, but represent large populations. The following are typhoid fever death-rates per 100,000 of population (corrected for age and sex distribution of population):

England and Wales	Average 1898-1902	Average 1903-7	Year 1908
Urban counties.....	19.3	9.9	8.4
Rural counties.....	10.4	6.8	5.6

The basis for these figures is indicated by the following from the report of the Registrar-General for 1901:

"On examining the local distribution of enteric fever it is found that, generally speaking, its mortality varies as the area affected contains either a large or a small proportion of urban population. For this reason a selection from among the counties of England and Wales has been made so as to show (a) in one list certain counties that are chiefly urban in character, and contain most of the industrial centers, and (b) in another list certain counties that are exclusively rural, or that contain a few small towns which although technically styled urban, nevertheless partake of that character to a slight extent only" (p. xlix).

The total population of these two selected groups comprises about two-thirds of the total population of England and Wales. The division is evidently arbitrary, but by no means blindly so. Inasmuch as a definite attempt is made to distinguish agricultural (i.e., small and segregated) communities from industrial (i.e.,

large and concentrated) communities, the division is much superior to statistical separations made solely on the basis of populations.

English and Scotch statistics thus agree in indicating for the smallest communities, i.e., the segregated agricultural communities, relatively low typhoid mortality. The excessive mortality in the "large town" districts of Scotland is, moreover, especially noteworthy.

As a matter of record the following references are also appended:

A. Dr. John H. McCollom, in a study (1893) of typhoid fever in Boston, by wards, attributed a slight increase in the frequency in Ward 4, a part of Charlestown, in all probability to "the fact that in this locality the majority of the population leave the city for a greater or less length of time during the summer months, and contract typhoid fever in the country."¹

B. "In England and Wales . . . [typhoid fever] destroys more lives in proportion to population in towns than in the country. . . . [In the United States] it is more prevalent in country districts than in cities, and, as Fulton has shown, the propagation is largely from the country to the town. . . . In Germany the larger cities have comparatively little typhoid fever. . . ."²

C. In a review of an investigation of typhoid fever at Ipswich, England, by Dr. A. M. N. Pringle, medical officer of health, who ascribed a diminution of typhoid fever in that town to the abolition of the "midden" system in favor of sewerage—a writer in the *Boston Transcript* for October 13, 1909, says:

"There is an important lesson for this country in this investigation, since it shows in Ipswich the typhoid conditions under the same kind of sanitary arrangements that obtain in the rural districts here. The autumnal rise in typhoid is so well marked here and its underlying reason is so clearly understood that it has been termed 'vacation typhoid.' It is a feature in northern American cities, and Dr. Pringle's article points directly to what is without doubt the most constant maintaining factor in the case."

D. "There is reason to believe that the term 'vacation typhoid' which has come into use is far from being without meaning."³

E. At the New York State Conference of Health Officers held at Rochester, November, 1909, U.S. Surgeon L. L. Lumsden stated:

"In the United States the rate of prevalence of typhoid fever is higher in the rural sections than in the cities and a city, surrounded by and obtaining its food supplies from a section of the country in which the typhoid rate is high, will have a high typhoid rate."⁴

F. A good example of current newspaper opinion is the following which appeared in an editorial in the *Boston Globe*, June 28, 1911:

"Typhoid and other fevers afflict humanity most immediately after summer vacations and are due generally to the insanitary conditions which have surrounded those who have been seeking pleasure and health away from home."

¹ *Boston Med. and Surg. Jour.*, 1893, 129, p. 296.

² William Osler, *Practice of Medicine*, 1910, p. 58.

³ *Bull. N.Y. State Dept. of Health*, 1909, p. 248.

⁴ *Ibid.*, 1909, p. 266.

The quotations given demonstrate without need of further comment the confusion of opinion and the obscurity in which the whole subject stands. When authorities differ, some affirming and others denying a widely prevalent opinion that typhoid fever is a "rural" disease, and is spread chiefly from country to city, a careful investigation is evidently required to settle the question by determining the facts.

3. DISCUSSION AND DEFINITION OF THE TERMS "URBAN" AND "RURAL."

The terms "urban" and "rural" are often used in a vague and general sense while at other times an apparent precision is introduced by arbitrary statistical definition. Thus the U.S. Census division of communities into urban and rural above and below the 8,000 population mark, which has been taken as a basis for study by Fulton and others, is a purely arbitrary line of demarkation and obviously not especially preferable to some other and perhaps lower figure.[†]

Nevertheless, as a basis for sanitary studies, it is necessary to bring together, if possible, and to compare, populations living under either closely corresponding or else strongly contrasting sanitary conditions; and this it is by no means easy to do. There are, for example, great differences in many respects in living conditions and therefore in sanitary conditions between (1) isolated farm-houses, (2) country villages, and (3) the somewhat larger and often compact communities which frequently cluster about a mill or a factory employing a hundred or several hundreds of operatives. Yet hundreds of all three of these and of many other classes are included in the "rural" group of the U.S. Census among communities having fewer than 8,000 inhabitants. Obviously, typhoid fever might prevail in group 3 and at the same time be very scarce in group 1; and yet it is often spoken of as "a rural disease" and ought therefore to be more abundant in the sparsely settled country than in the factory village of denser population.

[†] Since the above was written the United States Census (1910) has set the definitive figure at 2,500, which appears preferable to the old practice. We have, however, thought it wise to let our original discussion stand unaltered; first, because the Census division at 8,000 has been generally accepted as a basis by Fulton and others; and secondly, because we have endeavored to develop the general principle that *any* such arbitrary division of population, unless taken in the roughest sense, is misleading.

The sanitary conditions in a community having one, two, or three thousand inhabitants, and technically called "rural," may and often do more closely resemble those of the city than they do those of the country farmhouse or the sparsely settled hamlet. Such places may, for example, have public water-supplies, and sewerage systems, and if built closely around mills or factories, may possess typical city congestion and tenement-house crowding. Other communities, on the other hand, which under the Census division are also called "rural" may be in fact mill towns or factory towns which have gone beyond the stage of country villages but have not arrived at what are essentially city conditions. This state of development means that most of the dangerous conditions of the city have arrived, while public water-supply, sewerage, and adequate sanitary supervision have not yet been secured. "The state of change" has been called "the state of danger," and the dictum certainly applies in community life. Congestion is characteristically a city evil, but it is no less an evil when connected with the overgrowth of small mill or factory communities where it may exist in as great or even greater degree than in larger centers of population. Such communities, we repeat, are often denominated "rural" under any arbitrary classification which takes no account of the actual characteristics and distribution of housing, crowding, and other *sanitary* conditions of the various communities in question.

The definition used by the Census is, moreover, never exact, as the terms "urban" and "rural" are used without qualification. The inexperienced reader will often suppose these arbitrary statistical terms to be used in a true sense and will be misled as to the phenomena involved, while even the experienced reader may take the distinction to be the trustworthy result of careful analysis of conditions. Thus, while convenient for certain purposes, the terms may lead to erroneous confidence in a meaning which does not exist.

Other studies, e.g., those of the New York State Board of Health (see sec. 2) make no exact distinction, but arbitrarily separate out two groups, as by the criterion of incorporation or general order of magnitude of population. In the studies of Bolin, in Sweden, and of the Registrar-General of Scotland, the division

into rural and urban is equally arbitrary, in the former case by political, in the latter by sanitary, districts; although by special inquiry we have found that the lines in both these two cases are drawn at about 2,000 population.

In the study by Dr. S. W. Abbott, published in the Report of the Massachusetts State Board of Health for 1891, a different method is used, various degrees of density of population by area being used as a basis.

In no case, however, so far as we have been able to discover, has any detailed analytical description of the nature of the "rural" and "urban" populations studied been given,¹ a fact to which much vague thinking on this question may be attributed. Nor has any classification by degree of rural conditions, into more than two crude classes, been made. Rigid definitions of the terms must, in view of the complex character of the conditions, be untrustworthy if not misleading, yet it is nevertheless essential that the general conditions connoted by them be kept in mind.

The term "rural" (derived from the Latin *rus*, country) signifies strictly "of or pertaining to the country as distinguished from a city or town." A secondary meaning at once suggested by the primary one is "agricultural"—the first describing the place, the second the occupation of the inhabitants. It becomes necessary, therefore, to rule out from any group of rural communities all having essentially "city" conditions. The chief of these conditions, from the epidemiological standpoint, are: (1) the congestion characteristic of centers of population; and (2) systems for public convenience, such as public water-supplies, public sewerage systems, public milk-supplies, etc. City life is a state of concentration and even more or less congestion; country life of isolation or segregation. Consequently a purely rural area is one in which the dwellings are more or less widely separated and, instead of being dependent on the systems of public convenience mentioned as characteristic of the city, form in that respect wholly independent and disconnected units. Such a condition, strictly speaking, rarely exists, for everywhere little clusters of dwellings, or "hamlets,"

¹ A partial exception to this statement is found in the *Mass. State Census*, 1905, I, p. xxxii, where dissatisfaction with the U.S. Census division is expressed and a subdivision into rural (under 5,000), semi-urban (5,000-8,000), and urban (over 8,000) is made.

tend to spring up. It is, however, approximated in all really country life for even where there is community in certain sanitary conditions, such as, for example, a common source of provisions (many of which are, however, eaten only after cooking), or through a common school or a common church, the great sanitary factors, such as water-supply, milk-supply, and sewerage, remain practically separate, each dwelling having its own well, its own dairy, and its own privy or cesspool. Personal contact is also reduced to its lowest terms, and is largely confined to families. It is, then, between these two opposing conditions of *concentration* or *segregation* of homes or families that the study of urban vs. rural typhoid must be made; and it is only in the sense of *segregation in the country* that the term "rural" should be used for sanitary studies.

In given instances the conditions are usually complex. Congestion typical of city life may exist in one corner of a community otherwise rural in character, e.g., in a small factory village which though crowded lacks the city characteristics of common water-supply, sewerage, and milk-supplies. On the other hand, the suburbs of a city often have common water-supplies, milk-supplies, and sewerage, and yet approach rural conditions as to segregation of dwellings, absence of congestion, and of personal contact. In no instance can hard and fast lines be drawn, but the principle separating the two groups holds good. For statistical purposes it might be wished that the sanitary phenomena of large numbers of segregated farms could be studied and contrasted with those of typical cities, but practically, it is convenient to take separate towns (in New England), as the smallest units statistically available, and group them together for study according to their population.

To recapitulate, it is plain that any arbitrary division of population into "urban" and "rural," statistical or otherwise, which leaves out of account the facts we have mentioned is misleading. To conduce to a clear understanding of the conditions to be contrasted, we have framed the following characterizations of urban and of rural communities. Hereinafter we shall use the terms solely in these senses, except as otherwise indicated:

A rural community is one characterized by sparsity of population, with segregation of a few families upon a large area; it is accord-

ingly one in which the chief sanitary factors of water-supply, milk-supply, and sewerage are entirely separate for each household, and in which personal contact and association between the members of different families are reduced to their lowest terms.

An urban community is one characterized by density of population with concentration of many families upon a small area; it is therefore one in which some at least of the chief sanitary factors are common to many households, and in which much personal contact and association exist between the members of different families.

4. EVIDENCE DERIVED FROM THE VITAL STATISTICS OF THE STATE OF MASSACHUSETTS.

For the purpose of answering the apparently simple question which forms the subject of this paper, we have made a careful analytical and statistical study calculated to disclose the relative amounts of urban and rural typhoid fever, first, and especially, in Massachusetts, and afterward in the adjoining states of Connecticut and New Hampshire. Moreover, since urban and rural conditions invariably merge each into the other, and since the main object of our study has been to determine how the relative proportions of each affect the prevalence of typhoid fever, any merely rough or arbitrary division into these two classes is not enough. Our studies deal instead with a considerable number of *community groups* and have been designed to be in this respect much more searching, than any, as far as we know, hitherto made.

For several reasons we have chosen for intensive study the mortality statistics of the state of Massachusetts: first, because in Massachusetts we have statistics of approved accuracy covering a period of many years; in the second place, because Massachusetts either has been or now is the home of all three of the authors, and is therefore personally known to them in much detail; in the third place, both agriculture and manufacturing have long been and still are of great importance in Massachusetts, so that both the segregative influences of American agricultural life and the concentrative influences of industrial towns are here at work, side by side; fourthly, we have in this state the important advantage of the possibility of comparing the results of our own studies with the

earlier findings, already referred to, of Dr. Derby and Dr. Abbott, the accomplished secretaries of a state board of health highly reputed for its sanitary investigations and its leadership in sanitary subjects. Finally, we have in two states, contiguous to Massachusetts (Connecticut of much the same character as Massachusetts though somewhat less densely populated, and New Hampshire much more sparsely settled than either of the other states) materials for valuable "controls" and comparisons.¹

As a convenient and suitable statistical unit for our studies we have taken in all three states the New England "town"² which is thus defined by the *Century Dictionary*: "In many of the states one of the several subdivisions into which each county is divided, more accurately called, in the New England states and some others, township."

We have already pointed out above that any comparison of urban mortality with rural mortality over large areas is certain, in Massachusetts at least, to be inconclusive, for the reason that all over even the more rural portions of Massachusetts there are scattered spots or small areas to which the term "urban" ought in all fairness to be applied. These may be either old and settled communities which may or may not have supplied themselves with all modern conveniences such as public water-supply and sewerage systems, boards of health, and even garbage and refuse disposal; or they may be factory villages composed chiefly of tenement houses clustered about some busy mill or workshop but as yet destitute of all sanitary appliances and therefore from a sanitary standpoint perhaps actually worse than the neglected alleys of a crowded city. Obviously the blending of the mortality statistics of such spots as these with those of much larger and sparsely settled farming or forest areas into one group to which the term "rural" is arbitrarily applied, and any comparison of the net result with data drawn from places really urban, can give no true idea as to the relative prevalence of disease under strictly rural and

¹ According to the *Census of 1900*, Massachusetts stood second in the Union in order of density of population, with 349 persons per square mile; Connecticut fourth, with 188; and New Hampshire 15th, with 46.

² Certain of these are more exactly described as "cities," so that where towns and cities are grouped together we shall often employ the term "communities."

urban conditions. What we want is rather a comparison of the mortality of sparsely settled farming or forest areas with the mortality of closely crowded urban districts, and this, fortunately, we can approximately obtain in the New England states, divided as these are into towns (townships) usually of very moderate area and hence often entirely rural. Counties, on the other hand, in New England, as elsewhere, generally comprise much larger areas and include community groups of all sorts among which are often large cities.

The New England "town" as a community group may, to be sure, be large or small either in area or in population or in both, but as a rule the statements just made hold good and there are in every New England state many small towns which are in every respect strictly rural. Some, on the other hand, have, perhaps in one corner of the town, a little manufacturing settlement gathered about a mill or factory and it is true that:

"If the town is large the presumption is that it contains a considerable urban population, while if it is small it is probably all or nearly all rural" (*Mass. State Census*, 1905, I, p. xxxi).

The presumption here well set forth becomes a matter of reasonable certainty when the towns are viewed, as we shall view them, in considerable numbers.

For the purposes of our investigations of the mortality statistics of Massachusetts towns, we have used the following methods:

First, we have consulted the state registration reports for the years 1890-1907 inclusive and have computed from the data therein contained the annual death-rates from typhoid fever for the entire 18 years for every town in Massachusetts. The towns have then been arranged in 13 groups, according to their population, and the death-rates of the several *groups* from typhoid fever have also been computed. The results of both procedures are laid down in the following table (p. 163).

On Fig. 1 we have undertaken to show for the communities there grouped three sets of facts: first, by the *base line*, the average aggregate population for each group during the period under consideration; second, upon these base lines we have placed as *verticals* the average typhoid death-rates for the same period. The

TYPHOID FEVER DEATH-RATES (PER 100,000 OF POPULATION) IN MASSACHUSETTS COMMUNITIES GROUPED ACCORDING TO POPULATION. COMPUTED FROM THE MASSACHUSETTS STATE REGISTRATION REPORTS, 1890-1907, INCLUSIVE.

POPULATION GROUP		NUMBER OF COMMUNITIES	AVERAGE POPULATION 1890-1907	RATES BY YEARS																	Average Rate, 18 Years
				1890*	1891	1892	1893	1894	1895*	1896	1897	1898	1899	1900*	1901	1902	1903	1904	1905*	1906		1907
Less than 500 persons.....	36	12,300	31	19	54	35	17	38	31	0	31	23	15	0	14	0	24	0	16	0	19.3
500 to 1,000.....	57	44,600	32	17	23	42	33	17	34	25	9	12	5	5	5	12	10	15	17	2	18.8
1,000 to 1,500.....	47	57,600	25	28	36	20	21	14	19	19	20	25	16	10	14	12	13	23	14	10	19.3
1,500 to 2,000.....	38	66,500	30	40	24	20	21	15	30	17	14	16	18	20	6	9	11	14	21	16	19.1
2,000 to 3,000.....	42	101,500	28	36	35	27	32	23	26	22	24	16	18	11	10	11	11	11	10	10	20.7
3,000 to 4,000.....	24	79,000	28	39	15	29	20	25	20	9	27	21	18	22	27	14	10	11	15	3	19.1
4,000 to 5,000.....	24	69,000	26	33	25	25	34	25	29	12	11	18	17	15	17	14	15	18	3	18.1	
5,000 to 8,000.....	34	212,000	23	30	47	35	33	27	21	19	19	18	18	13	15	13	11	15	11	5	19.3
8,000 to 10,000.....	16	69,560	40	32	30	38	35	22	22	20	34	19	18	13	15	10	12	20	14	21.5	
10,000 to 15,000.....	16	197,000	29	33	38	32	31	35	27	22	20	28	20	28	20	13	14	19	15	21.8	
15,000 to 25,000.....	7	149,000	25	27	35	38	32	30	28	21	25	28	25	18	22	22	19	14	19	24.5	
25,000 to Worcester (110,000), incl.	20	1,042,000	53	43	43	38	35	32	35	30	44	22	28	20	28	21	15	18	15	20.5	
Boston.....	1	528,700	33	33	30	28	28	32	33	31	33	28	25	24	24	20	21	20	20	10	20.3
The state.....	354	2,680,560	37	36	35	31	31	27	28	23	25	22	22	20	19	18	16	17	16	13	24.3

* Census years. Population for intervening years estimated by method of U. S. Census.

area of the resultant rectangle represents the actual number of deaths in each group annually. In this way we have plotted both the death-rates and the absolute number of deaths from typhoid fever during the period under consideration in Massachusetts communities of various sizes.

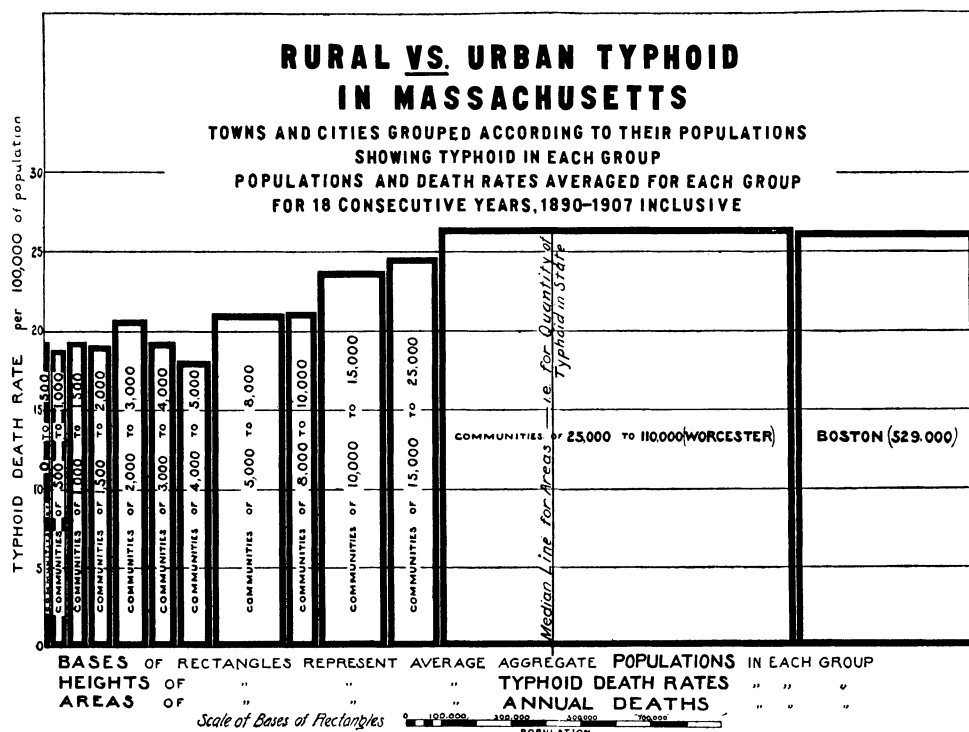


FIG. 1.

It will be observed that the plate shows a fairly regular increase in the death-rates as we proceed from communities of small to those of larger size; and if we consider the areas, that is the absolute quantity or number of deaths, the great balance in favor of the smaller communities and against the larger is very striking. As some further gauge of the distribution of the typhoid deaths, we have indicated in the diagram a line which may be called the *median line* determined by the fact that it divides the total area, that is, the total number of deaths, into two equal parts. In this way a

TYPHOID FEVER MORTALITY IN MASSACHUSETTS COMMUNITIES GROUPED ACCORDING TO POPULATION. DEATH-RATES PER 100,000 OF POPULATION. SIX CENSUS (U.S. OR STATE) YEARS ONLY. COMPILED AND COMPUTED FROM THE STATE REGISTRATION REPORTS.

POPULATION GROUP	1880				1885				1890			
	Number of Communities	Sum of Component Populations	Sum of Typhoid Deaths	Typhoid Death-Rate	Number of Communities	Sum of Component Populations	Sum of Typhoid Deaths	Typhoid Death-Rate	Number of Communities	Sum of Component Populations	Sum of Typhoid Deaths	Typhoid Death-Rate
Less than 500 persons.	22	7,829	3	38	23	7,981	7	88	28	9,772	3	31
500 to 1,000	61	46,474	19	41	72	55,188	19	34	87	52,133	17	33
1,000 to 2,000	92	132,409	66	50	83	122,060	48	39	84	122,798	34	28
2,000 to 3,000	53	127,201	91	72	54	133,256	57	43	48	119,231	45	38
3,000 to 4,000	38	113,969	58	51	29	103,728	41	40	22	73,619	31	41
4,000 to 5,000	28	124,358	77	62	24	106,666	35	33	30	134,154	32	24
5,000 to 6,000	10	54,408	38	70	8	49,810	16	32	7	37,036	7	19
6,000 to 7,000	4	25,550	7	27	8	43,763	22	50	9	57,844	12	21
7,000 to 8,000	6	44,274	15	34	4	29,100	28	31	9	63,825	18	27
8,000 to 9,000	4	38,021	13	39	6	59,547	28	47	5	42,672	14	33
9,000 to 10,000	5	18,338	10	57	5	46,297	9	19	5	47,173	22	47
10,000 to 11,000	2	52,389	18	31	2	21,661	10	46	5	54,462	15	29
11,000 to 12,000	3	34,109	18	53	2	23,266	11	47	2	22,147	2	9
12,000 to 13,000	3	36,618	17	46	3	37,381	17	45	1	12,103	0	0
13,000 to 14,000	3	49,510	22	54	2	26,861	7	26	3	41,251	15	36
14,000 to 15,000	0	.....	1	..	2	29,975	5	17	2	29,080	14	48
15,000 to 20,000	3	54,796	15	27	3	51,541	17	33	4	68,783	24	38
20,000 to 25,000	4	89,843	48	51	4	87,955	32	36	4	94,098	17	18
25,000 to 50,000	6	214,134	128	60	8	207,362	111	42	10	344,219	157	40
50,000 to 100,000	3	170,435	63	37	4	249,624	116	47	5	305,504	268	57
100,000 or over	1	302,839	151	42	1	396,393	148	38	1	445,477	146	33
The state	345	1,783,685	879	49.3	348	1,942,141	765	39.4	351	2,238,643	833	37.2

TYPHOID FEVER MORTALITY IN MASSACHUSETTS COMMUNITIES IN (SIX) CENSUS YEARS—Continued.

POPULATION GROUP	1895				1900				1905			
	Number of Com- munities	Sum of Component Popula- tions	Sum of Typhoid Deaths	Typhoid Death- Rate	Number of Com- munities	Sum of Component Popula- tions	Sum of Typhoid Deaths	Typhoid Death- Rate	Number of Com- munities	Sum of Component Popula- tions	Sum of Typhoid Deaths	Typhoid Death- Rate
Less than 500 persons.	36	13,287	5	3.8	37	13,383	2	1.5	36	12,513	0	0
500 to 1,000.....	9	45,864	18	3.9	33	41,442	5	1.2	54	40,537	6	1.5
1,000 to 2,000.....	80	124,719	18	14	89	129,991	23	18	85	123,870	23	19
2,000 to 3,000.....	41	100,555	23	23	37	88,785	14	16	43	100,993	11	11
3,000 to 4,000.....	23	76,902	19	25	27	93,751	17	18	18	62,709	7	11
4,000 to 5,000.....	23	184,395	25	24	17	76,412	9	12	20	85,249	13	15
5,000 to 6,000.....	15	80,173	16	20	19	102,514	20	20	15	81,038	14	17
6,000 to 7,000.....	11	69,668	19	27	7	44,836	8	18	13	84,643	13	15
7,000 to 8,000.....	10	76,315	20	34	11	81,669	14	17	10	73,437	9	12
8,000 to 9,000.....	0	59,796	13	26	4	34,212	3	9	5	42,453	5	12
9,000 to 10,000.....	4	37,891	7	18	5	47,549	15	32	4	37,490	5	13
10,000 to 11,000.....	2	21,770	10	47	3	31,233	1	32	2	20,286	3	15
11,000 to 12,000.....	5	58,385	10	27	6	67,994	19	28	5	50,510	9	16
12,000 to 13,000.....	0	.....	..	..	3	37,604	5	13	5	61,904	13	21
13,000 to 14,000.....	0	.....	..	..	4	54,404	5	9	3	39,814	10	25
14,000 to 15,000.....	4	18,181	20	34	2	28,732	10	35	6	80,252	10	19
15,000 to 20,000.....	5	87,638	37	43	4	75,989	19	25	3	54,866	13	24
20,000 to 25,000.....	3	62,049	17	27	5	117,682	27	23	3	63,777	4	6
25,000 to 50,000.....	10	308,406	167	52	10	348,917	92	26	14	483,807	94	19
50,000 to 100,000.....	9	627,471	166	26	7	804,971	120	24	7	550,589	94	17
100,000 or over.....	1	496,920	100	32	3	784,176	204	26	3	829,277	157	19
The state	353	2,500,183	680	27.2	353	2,805,346	632	22.5	354	3,003,680	519	17.3

certain size of community is found such that the two groups of communities of small size and larger size, respectively, have the same absolute number of deaths. The median line, therefore, indicates where the actual deaths would exert their center of gravity, so to speak; and for Massachusetts, as shown upon Fig. 1, this median line falls in the left-hand part of the "25,000 to Worcester (incl.)" group. Similar subdivision into smaller groups would show exactly at what size of community the median line falls, but the example just given is sufficient for our purpose. Tried by this test, the bulk of the deaths certainly does not rest upon the more rural towns but rather upon the least rural namely, the largest cities. From this demonstration, therefore, we arrive at our first conclusion, which is that *typhoid fever is not chiefly a rural but rather an urban disease*. Obviously, however, this conclusion applies only to what we may call the mass of typhoid, or of typhoid fever microbes or of typhoid fever material, which would naturally be expected if gathered together to be greater in large than in small populations.

Next, in order to eliminate inaccuracies due to estimates of populations for non-censal years, and to carry our group analysis further, we have studied for six Census years 1880, 1885, 1890, 1895, 1900, and 1905 the typhoid fever mortality of the various communities of Massachusetts arranged according to their population into 21 groups. The rate columns in the above table were calculated by computing for each Census year the typhoid fever death-rate for every town in Massachusetts, each town being assigned to the group into which it fell for the particular Census year. The table shows the results of these computations.

We have then averaged the first two Census years against the last four. The results are shown in the following table (p. 168).

The figures given in this last table are plotted for easy reference and further study upon Fig. 2, in which the method of presentation corresponds with that used in Fig. 1 and in which the same scales are employed for both upper and lower diagram, and Fig. 2, taken together with the table, demonstrates some of the most striking results of our investigation, namely, as follows:

1. In the first place it appears that the total population of the

state increased between the earlier and the later years about 40 per cent. This increase was chiefly among the cities having more than 25,000 population, although it was shared by many communities ranging from 5,000 upward. On the other hand, population in towns having less than 5,000 actually decreased by some 15 per cent. This movement of the population must be carefully kept in mind wherever conclusions are to be drawn.

TYPHOID FEVER DEATH-RATES (PER 100,000 OF POPULATION) IN MASSACHUSETTS COMMUNITIES GROUPED ACCORDING TO POPULATION (CENSUS YEARS).

COMMUNITIES HAVING POPULATIONS OF	AVERAGES FOR 1880 AND 1885		AVERAGES FOR 1890, 1895, 1900, AND 1905	
	Population	Typhoid Death-Rate	Population	Typhoid Death-Rate
Less than 500.....	7,900	63	12,240	21
500 to 1,000.....	50,830	38	45,000	23
1,000 to 2,000.....	127,290	45	125,340	20
2,000 to 3,000.....	130,230	58	102,390	22
3,000 to 4,000.....	108,620	46	77,250	24
4,000 to 5,000.....	115,490	48	100,800	19
5,000 to 6,000.....	52,110	51	75,340	19
6,000 to 7,000.....	34,050	39	64,120	20
7,000 to 8,000.....	36,690	33	74,300	22.5
8,000 to 9,000.....	46,280	43	42,530	20
9,000 to 10,000.....	32,320	53	42,530	27.5
10,000 to 11,000.....	37,030	39	31,290	31
11,000 to 12,000.....	28,690	50	51,260	20
12,000 to 13,000.....	37,100	46	27,930	11
13,000 to 14,000.....	33,700	40	33,870	23
14,000 to 15,000.....	14,540	17	50,550	34
15,000 to 20,000.....	53,170	30	71,070	32
20,000 to 25,000.....	88,900	44	84,900	18.5
25,000 to 50,000.....	240,750	51	371,350	28
50,000 to 100,000.....	209,730	42	512,660	31
100,000 to 130,000.....	.....	..	114,300	27.5
Boston.....	376,620	40	525,420	27.5
State of Massachusetts.....	1,862,610	44.35	2,637,040	26.05

2. Inasmuch as the deaths were, on the whole, somewhat less for the various communities during the later years (owing, no doubt, to general sanitary improvements) and while, as we have just said, the population increased during the same period, the typhoid fever death-rates, as indicated by the diagram, declined for the most part conspicuously, between the earlier and the later years.¹

¹ The question may be raised at this point as to how far this decline in death-rates is attributable to improved methods of diagnosis. It is of course true that with the establishment and growth of hospitals and the general improvement of facilities for medical observation and investigation, accuracy in the diagnosis of typhoid fever has been much increased since 1880. We are not at present, however, especially concerned with the reasons underlying the general decline in death-rates, and we see no reason for suspecting that any quantitative relation of rural and urban typhoid has been much obscured by changes in methods of diagnosis, or that improved diagnosis could have brought about any merely apparent reversal in that relation between 1880 and 1907. We shall return to this subject in a later section.

**TOWNS AND CITIES GROUPED ACCORDING TO THEIR POPULATIONS
SHOWING TYPHOID IN EACH GROUP**

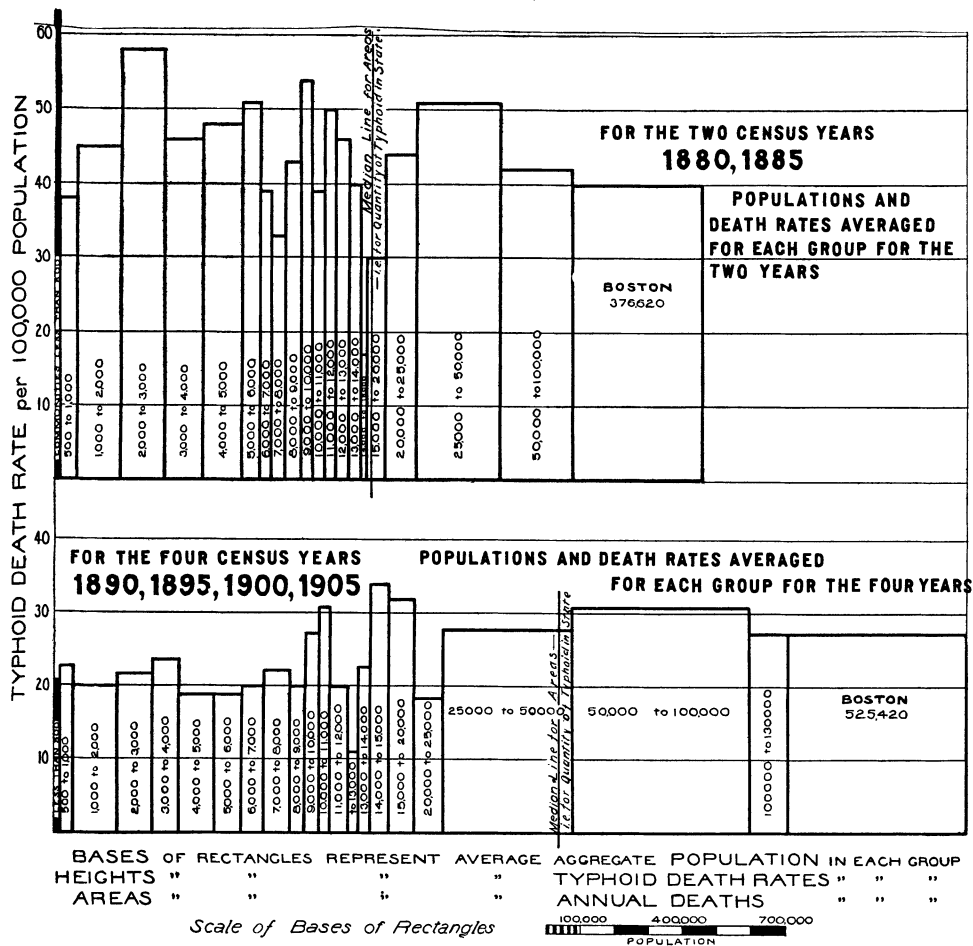


FIG. 2.

3. The decline in the amount of typhoid fever as indicated by the decline in death-rates from that disease was considerably greater among the smaller than among the larger communities. This decline is especially noteworthy in the groups having less than 6,000 population.

4. The median line for areas (i.e., for the number of deaths) falls for 1880 and 1885 in the vicinity of populations of 15,000, and for the later years has moved toward a much larger community-size, namely, about 50,000 population.

5. The most important result disclosed by the diagram for our purposes is, however, that in the earlier period the groups of smaller communities showed the highest typhoid fever death-rates, while in the later years this relation is reversed.

The results here obtained are in close accordance with the findings, referred to above, of Dr. S. W. Abbott, who confirmed the earlier study of Dr. Derby, and attributed to the smaller communities previous to 1891 a relatively greater prevalence of typhoid fever. It appears, however, that (as is stated in the last paragraph) an exact reversal of this relation appears to have taken place since the period covered by Dr. Abbott's study, namely, 1871-90. It becomes an interesting question what precisely has led to this singular reversal, which apparently compels us to conclude that whereas before 1890 typhoid fever was in fact a rural disease, since that time it has gradually become an urban disease—a curious circumstance, and one which, if confirmed, justifies both the conclusions of earlier authorities like Drs. Derby and Abbott, and also the suspicion and incredulity which impelled us to undertake the present investigation. To a further consideration of this point we shall return hereafter.

Finally, in order to carry into still greater detail the studies described above and to establish a basis of comparison for the present time with the interesting studies of individual towns made by Drs. Derby and Abbott, we have calculated for the period of 18 years already under consideration, beginning with 1890, the average annual death-rate from typhoid fever for the various communities of the state of Massachusetts. These have then been arranged in the order of their typhoid fever death-rates in the following table:

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AVERAGE ANNUAL TYPHOID FEVER DEATH-RATES PER 100,000 OF POPULATION,
MASSACHUSETTS COMMUNITIES, 1890-1907, INCLUSIVE.

Community	Average Population 1890-1907	Typhoid Death-Rate	Community	Average Population 1890-1907	Typhoid Death-Rate
TOWNS WITH NO DEATHS					
Gosnold.....	150	0	Sudbury.....	1,162	9.7
Alford.....	281	0	Easthampton.....	5,551	9.9
Boxborough.....	318	0	Whitman.....	5,868	9.9
Prescott.....	370	0	Lincoln.....	837	9.9
Shutesbury.....	413	0	Harvard.....	1,118	9.9
Plainfield.....	418	0	Bourne.....	1,616	9.9
Westhampton.....	472	0	Total population...	70,318	
Wendell.....	501	0	TOWNS AND CITIES WITH RATE 10-15		
Halifax.....	519	0	Holliston.....	2,649	10.4
Rowe.....	530	0	Groton.....	2,138	10.5
Plympton.....	537	0	Southboro.....	2,047	10.5
Windsor.....	549	0	Warwick.....	577	10.6
Oakham.....	612	0	Canton.....	4,625	10.8
Richmond.....	694	0	Raynham.....	1,515	10.9
Princeton.....	954	0	Manchester.....	2,201	10.9
Millis.....	1,024	0	Lexington.....	3,849	10.9
Wellfleet.....	1,051	0	Savoy.....	530	11.0
Sandwich.....	1,570	0	Enfield.....	988	11.1
Total population....	10,963		Southampton.....	1,102	11.1
Plainville (1905-7 only. Incorporated 1904)...	1,300	0	Westminster.....	1,425	11.1
Westwood (1900-1907 only, Incorporated 1899).....	1,124	0	Newbury.....	1,499	11.1
TOWNS WITH RATE 0-5			Ashland.....	1,936	11.1
Nantucket.....	3,031	1.8	Hanover.....	2,119	11.1
Rehoboth.....	1,857	3.0	Hingham.....	4,843	11.5
Freetown.....	1,421	4.0	Heath.....	444	11.7
Pembroke.....	1,261	4.2	Conway.....	1,388	11.7
Bedford.....	1,169	4.4	East Longmeadow.....	1,368	11.9
Total population....	8,739		Shirley.....	1,465	11.9
TOWNS WITH RATE 5-10			Easton.....	4,695	12.0
Ashfield.....	988	5.4	Lancaster.....	2,316	12.1
Stow.....	963	5.5	Monterey.....	464	12.2
Southwick.....	991	5.6	Mendon.....	910	12.2
Gill.....	1,020	5.8	Ayer.....	2,270	12.2
Truro.....	811	6.2	Paxton.....	443	12.3
Shrewsbury.....	1,616	6.7	Seekonk.....	1,593	12.4
Lynnfield.....	822	6.8	Avon.....	1,663	12.4
Ashby.....	842	6.9	Hatfield.....	1,672	12.4
Holbrook.....	2,377	6.9	Hawley.....	465	12.5
Wellesley.....	4,938	7.0	Chatham.....	1,786	12.5
Brookline.....	18,679	7.2	North Brookfield.....	3,935	13.0
Marion.....	800	7.3	Milton.....	6,048	13.0
Granby.....	780	7.3	Yarmouth.....	1,622	13.1
Falmouth.....	3,032	7.7	Florida.....	419	13.3
Hopkinton.....	2,957	8.0	Monson.....	3,827	13.5
Georgetown.....	1,960	8.5	Medway.....	2,827	13.6
Rutland.....	1,251	8.6	Littleton.....	1,300	13.7
Walpole.....	3,379	8.7	Brewster.....	849	13.7
Orleans.....	1,148	9.2	Dedham.....	7,432	13.7
Burlington.....	593	9.5	Whately.....	781	13.8
West Bridgewater.....	1,845	9.6	Bridgewater.....	5,518	13.9
Marshfield.....	1,761	9.6	Barnardston.....	777	14.0
New Braintree.....	523	9.7	Hampden.....	720	14.1
			Bolton.....	780	14.2
			Hull.....	1,449	14.2
			Hamilton.....	1,394	14.3
			Belmont.....	3,453	14.3
			Franklin.....	5,091	14.3
			Shelburne.....	1,529	14.5
			Northfield.....	1,933	14.5
			Mansfield.....	3,906	14.5
			Ware.....	8,044	14.5
			Merrimac.....	2,237	14.6
			Barnstable.....	4,219	14.6
			Medfield.....	2,590	14.7
			Marlboro.....	14,105	14.7

AVERAGE ANNUAL TYPHOID FEVER DEATH-RATES PER 100,000 OF POPULATION,
MASSACHUSETTS COMMUNITIES, 1890-1907, INCLUSIVE—Continued.

Community	Average Population 1890-1907	Typhoid Death-Rate	Community	Average Population 1890-1907	Typhoid Death-Rate
Boxford	740	14.8	North Andover	4,087	18.7
Mattapoisett	1,105	14.8	Monroe	288	18.8
Gloucester	26,428	14.9	Wenham	886	18.8
Fitchburg	28,886	14.9	North Reading	912	18.9
Total population....	201,016		Eastham	525	19.0
TOWNS AND CITIES WITH RATE 15-20			West Brookfield	1,473	19.0
Millbury	4,719	15.0	Chesterfield	593	19.1
Winchester	6,854	15.0	Weston	1,851	19.1
Dana	742	15.1	Northboro	2,001	19.2
Kingston	1,891	15.1	Upton	1,997	19.3
Stoneham	6,256	15.1	Watertown	9,215	19.3
Leominster	11,077	15.1	Frammingham	10,537	19.6
Sheffield	1,859	15.2	Sherborn	1,422	19.7
Stoughton	5,457	15.4	Hinsdale	1,581	19.7
Spencer	7,070	15.6	Longmeadow	1,144	19.8
Tyngsboro	709	15.7	Brookfield	2,983	19.9
Hadley	1,764	15.7	Westford	2,426	19.9
Wayland	2,152	15.8	Hyde Park	12,723	19.9
Winthrop	5,292	15.8	Total population....	505,595	
Topsfield	1,045	15.9	TOWNS AND CITIES WITH RATE 20-25		
Wareham	3,487	16.0	Cohasset	2,602	20.0
Swampscott	4,140	16.2	Egremont	790	20.1
South Hadley	4,623	16.2	Abington	4,557	20.2
Saugus	5,109	16.2	Montgomery	268	20.3
Concord	5,251	16.3	North Attleboro	7,104	20.4
Middleboro	6,695	16.3	Sunderland	760	20.5
Peabody	11,501	16.3	Braintree	5,885	20.7
West Newbury	1,600	16.4	Plymouth	9,180	20.7
Rockport	4,673	16.5	Lynn	67,336	20.7
Newton	31,375	16.5	Southbridge	9,439	20.8
Hardwick	3,022	16.7	Everett	22,011	20.8
Revere	9,485	16.7	Warren	4,432	20.9
Swansea	1,642	16.8	West Springfield	6,805	20.9
Peru	283	17.0	Athol	7,062	21.0
Sterling	1,200	17.0	Billerica	2,644	21.1
Essex	1,688	17.0	Wakefield	8,935	21.1
Duxbury	1,094	17.0	Charlmont	1,027	21.2
Pepperell	3,381	17.0	Dartmouth	3,460	21.2
East Bridgewater	3,014	17.0	Norwell	1,567	21.3
Montague	6,412	17.0	Hubbardston	1,263	21.4
Amherst	4,963	17.2	Stockbridge	2,078	21.6
Andover	6,465	17.2	Chelmsford	3,624	21.6
Foxboro	3,217	17.3	Somerville	57,790	21.6
Fairhaven	3,799	17.3	Sharon	1,874	21.7
Danvers	8,422	17.5	Taunton	29,061	21.7
Auburn	1,689	17.6	Malden	32,050	21.7
Arlington	7,849	17.6	Dudley	3,436	21.8
Goshen	298	17.7	Great Barrington	5,335	21.8
Brimfield	974	17.8	Palmer	7,315	21.8
Bellingham	1,547	17.8	Brockton	38,424	21.8
Westboro	5,381	17.8	Ashburnham	1,900	21.9
Melrose	12,291	17.8	Northampton	17,915	22.0
West Boylston	2,404	18.0	Acton	2,010	22.1
Deerfield	2,458	18.0	Leicester	3,317	22.1
Templeton	3,338	18.0	Clarksburg	1,009	22.2
Barre	2,283	18.1	Greenfield	7,391	22.2
Medford	16,450	18.1	Chelsea	33,260	22.3
Buckland	1,516	18.2	Carlisle	494	22.4
Reading	4,977	18.2	Erving	1,001	22.4
Mashpee	312	18.3	Lunenburg	1,252	22.4
Norfolk	903	18.3	Gardner	10,335	22.5
Middleton	917	18.5	Woburn	14,151	22.6
Berlin	922	18.5	Rockland	5,661	22.8
Cambridge	87,650	18.5	Hancock	475	22.9
Worcester	110,400	18.5	Lenox	2,948	22.9

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AVERAGE ANNUAL TYPHOID FEVER DEATH-RATES PER 100,000 OF POPULATION,
MASSACHUSETTS COMMUNITIES, 1890-1907, INCLUSIVE—*Continued.*

Community	Average Population 1890-1907	Typhoid Death-Rate	Community	Average Population 1890-1907	Typhoid Death-Rate
Oxford.....	2,652	23.0	Tyringham.....	368	29.7
Marblehead.....	7,606	23.0	Agawam.....	2,273	29.8
Charlton.....	1,927	23.1	Total population....	941,948	
Orange.....	5,335	23.1	TOWNS AND CITIES WITH RATE 30-40		
Quincy.....	23,101	23.1	Tisbury.....	1,194	30.1
Norwood.....	5,098	23.2	Northbridge.....	6,257	30.2
Beverly.....	13,211	23.2	Dennis.....	2,494	30.7
Huntington.....	1,440	23.3	Salisbury.....	1,474	30.8
Tewksbury.....	3,631	23.3	Sturbridge.....	2,004	31.0
Wilmington.....	1,475	23.4	Wrentham.....	2,324	31.2
Attleboro.....	10,293	23.4	Gay Head.....	165	31.4
Petersham.....	927	23.6	Dalton.....	3,080	31.4
Berkeley.....	932	23.6	Russell.....	893	31.9
Nahant.....	963	23.6	Wilbraham.....	1,724	32.1
Holden.....	2,582	23.6	Otis.....	528	32.4
Weymouth.....	11,319	23.7	Lee.....	3,865	32.7
Clinton.....	12,312	23.7	Groveland.....	2,330	33.0
Waltham.....	24,832	24.0	Provincetown.....	4,433	33.3
Westport.....	2,759	24.3	Acushnet.....	1,162	33.6
Lakeville.....	919	24.4	Chilmark.....	326	34.8
Natick.....	9,516	24.6	Phillipston.....	461	34.9
Dover.....	672	24.8	Pelham.....	473	34.9
Total population....	594,800		Scituate.....	2,408	35.0
TOWNS AND CITIES WITH RATE 25-30			Royalston.....	945	35.3
Townsend.....	1,776	25.0	Cheshire.....	1,246	35.5
Holyoke.....	43,850	25.6	Rochester.....	1,050	36.3
Washington.....	388	25.8	Chicopee.....	17,869	36.5
Oak Bluffs.....	1,089	25.8	Belchertown.....	2,165	36.9
New Marlboro.....	1,271	25.8	Hopedale.....	1,672	37.5
Winchendon.....	5,045	26.0	Newburyport.....	14,471	37.7
Hudson.....	5,523	26.2	Harwich.....	2,473	38.1
Colrain.....	1,792	26.3	Tolland.....	313	38.2
Boston.....	535,477	26.3	Douglas.....	2,042	38.2
Pittsfield.....	21,633	26.3	New Salem.....	601	38.5
Dunstable.....	414	26.5	Sutton.....	3,230	38.9
Grafton.....	5,012	26.6	Total population....	85,672	
Milford.....	10,498	26.7	TOWNS AND CITIES WITH RATE 40-50		
Maynard.....	3,851	27.0	Greenwich.....	493	40.7
Ipswich.....	4,808	27.0	Ludlow.....	3,050	41.7
Haverhill.....	35,774	27.0	West Stockbridge.....	1,232	42.0
Fall River.....	95,715	27.2	Lawrence.....	59,018	43.4
Webster.....	7,606	27.4	Granville.....	995	43.4
Middlefield.....	412	27.5	Hanson.....	1,398	43.4
Holland.....	230	27.8	Lanesboro.....	873	43.6
Boylston.....	878	27.9	Lowell.....	89,100	43.7
Norton.....	1,826	27.9	North Adams.....	20,871	46.2
Uxbridge.....	3,639	27.9	Blandford.....	825	48.5
Williamsburg.....	1,901	28.0	Becket.....	929	48.5
Dighton.....	1,889	28.1	Total population....	178,784	
Somerset.....	2,156	28.1	TOWNS WITH RATE OVER 50		
Williamstown.....	4,682	28.2	Carver.....	1,131	50.4
Randolph.....	3,913	28.3	Blackstone.....	5,994	52.9
Amesbury.....	9,494	28.5	Adams.....	10,317	53.3
Westfield.....	11,840	28.5	Leyden.....	388	57.6
Needham.....	3,712	28.7	Sandisfield.....	732	63.2
Methuen.....	6,918	28.7	Mt. Washington.....	123	77.4
New Bedford.....	60,523	28.7	Leverett.....	723	84.2
Edgartown.....	1,166	28.8	New Ashford.....	112	90.4
Chester.....	1,374	28.8	Total population....	19,430	
Salem.....	35,204	28.8			
Rowley.....	1,325	29.2			
Dracut.....	2,857	29.2			
West Tisbury.....	453	29.3			
Wales.....	725	29.3			
Cummington.....	758	29.5			

Populations based on U.S. Census for 1890 and 1900, and State Census for 1895 and 1905. Deaths from State Registration Reports.

From these detailed tables another, and general one, may be made enabling us to compare at a glance the typhoid fever death-rates of communities of various sizes (or population) for the 18 years under consideration as follows:

MASSACHUSETTS COMMUNITIES ARRANGED BY POPULATION GROUPS AND TYPHOID FEVER DEATH-RATES (PER 100,000) FOR THE YEARS 1890-1907, INCLUSIVE.

TYPHOID DEATH-RATE AT OR BETWEEN	AVERAGE POPULATION OF COMMUNITIES, 1890-1907							
	Under 1,000	1,000- 2,000	2,000- 3,000	3,000- 5,000	5,000- 10,000	10,000- 25,000	25,000- 125,000	Over 125,000
0.....	7,318	3,645	0	0	0	0	0	0
0-5.....	0	4,708	0	3,031	0	0	0	0
5-10.....	9,040	14,497	5,334	11,349	11,419	18,679	0	0
10-15.....	9,905	28,834	23,313	37,352	32,133	14,165	55,314	0
15-20.....	9,324	29,002	16,707	55,359	101,813	74,579	229,425	0
20-25.....	7,200	15,735	20,280	20,457	107,727	159,480	257,921	0
25-30.....	4,026	15,379	7,286	24,605	39,598	43,971	271,066	535,417
30-40.....	4,705	9,522	18,240	14,608	0,257	32,340	0	0
40-50.....	4,115	2,030	0	3,050	0	20,871	141,118	0
Over 50.....	2,078	1,131	0	0	5,904	10,317	0	0
Totals.....	58,311	125,083	91,160	175,811	304,851	374,402	961,844	535,417

The data shown upon the foregoing basic or detailed tables are presented graphically upon Fig. 3, where the typhoid fever death-rates of the various communities of Massachusetts as arranged in the tables have been plotted diagrammatically in the same order of succession. The vertical bars represent by their height the population of each community, and in the case of some of the largest towns and cities these bars have had to be broken off in order to bring them within the limits of the diagram. Whenever this has been done the bar has been broken in the middle, the upper half omitted, and the actual population indicated upon the remaining lower half. The authors are personally familiar with many of the towns and cities of Massachusetts, but it would be impossible without unduly lengthening the present paper to take up for consideration the individual communities. We shall therefore merely point out some of the more salient features developed by the diagram.

The observer cannot fail to be struck by the absence from the upper line of the series (which represents communities having the lowest typhoid fever death-rates) of communities of the larger or even medium size. On the contrary, many of the very smallest

here find a place, and, with the single exception of Brookline, there is no community among the first 110 of the series which has a population of more than 8,000—the dividing line, it will be remembered, of the U.S. Census of 1900 between rural and urban com-

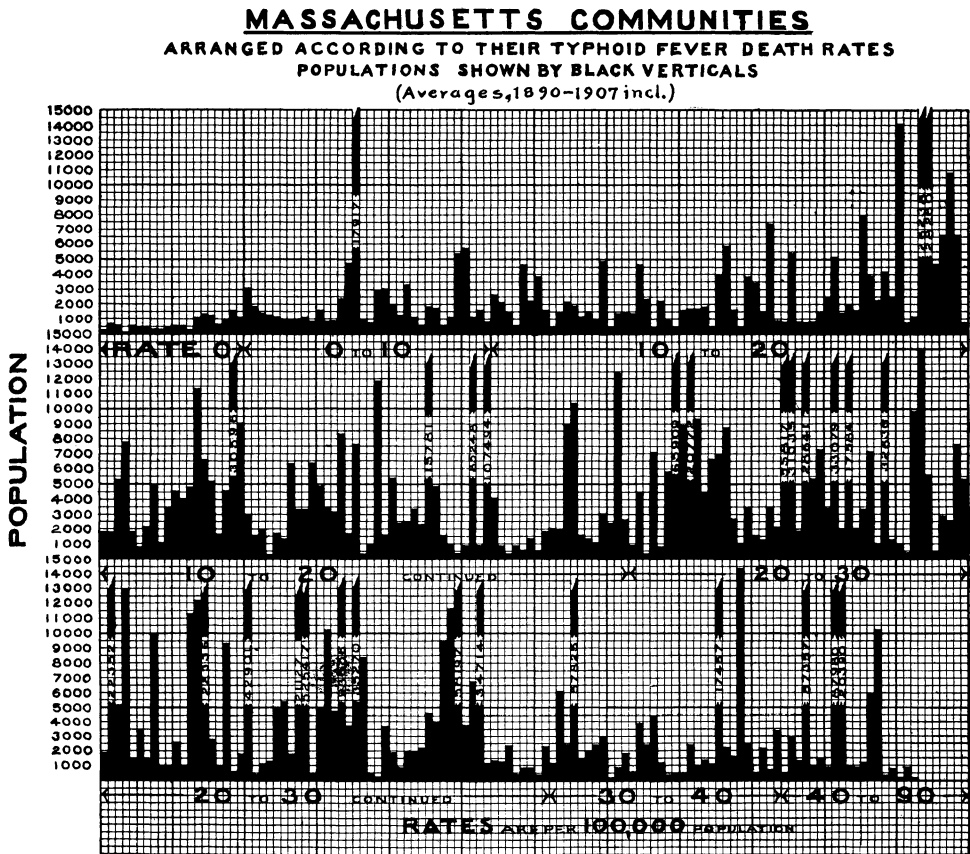


FIG. 3.

munities—while the majority (61) of these, are well under 1,500 population. It is certainly a significant fact that of 20 towns which had no deaths whatever from typhoid fever during the 18 years under consideration, only one had more than 1,500 population.

Passing from the lower death-rates to the higher, towns of medium size and large size become more frequent, although there are scattered among these all the way along a few of the more

strictly rural communities. When we reach the groups having death-rates of 20-30, the number of communities having 15,000 population and upward is remarkable. Rates 30-40 and 40-90 are represented by comparatively few communities of any kind and those of various sizes.

Going more into details we find from rate 0 to rate 10 per 100,000 only one community in 54 with as many as 6,000 population, most of the other 53 falling below 2,000. Low populations continue to be associated with low death-rates well into the next (rate 10 to 20) group but as we advance toward rate 20 per 100,000 a large number of comparatively urban communities appear. These are still more conspicuous as we pass into the region of rate 20 to 30, but become less frequent as we pass the rate 30 line. Beyond this line low populations with high typhoid death-rates are again more abundant, although out of the 51 communities having death-rates of 30 or more per 100,000, nine have 6,000 or more population. Again, out of the 55 communities having the lowest death-rates from typhoid fever 54 had less than 6,000 population, while out of the 51 having the highest death-rate only 42 had less than 6,000.

As to the total population in the rate 0 to rate 10 group we find that this is about 90,000, while that in the group between rate 30 and rate 90 is very much larger. The former is distinctly a rural group; the latter much more urban. In view of this presentation of the subject it is hard to believe that typhoid fever today is, in any true sense of the term, "a rural disease."

We may now bring together the most obvious results of our studies above described upon the prevalence of typhoid fever in Massachusetts communities of various sizes:

Among the twelve groups taken for study for the entire period, 1890-1907, typhoid fever is not found to be either absolutely or relatively to the population a "rural" disease. On the contrary, during this period, typhoid fever has prevailed somewhat more among larger than among smaller communities.

Our second analysis (of 21 groups confined to Census years) confirms this result and in addition brings out the fact that this was not the case prior to 1890, thus confirming the earlier findings

and opinions of Drs. Derby and Abbott and also probably explaining the origin of the belief of today that typhoid fever is a rural disease.

The results of a detailed study of the more than 350 communities into which Massachusetts is divided, confirms and strengthens the foregoing conclusions, by showing that a large number of the smallest and most rural communities are among those having the lowest typhoid fever death-rates, as well as a scarcity among the latter of communities of large size; and, on the other hand, revealing a notable concentration of relatively large communities in the groups having comparatively high death-rates.

We are evidently driven by all our considerations to the conclusion that no matter whether we take as a basis the total amount of typhoid fever material existing in the various communities of the state, or the specific death-rates from that disease, typhoid fever in Massachusetts since 1890 cannot possibly be regarded as "a rural disease." It appears, on the contrary both from our tables and our diagrams, not only that there is very much more typhoid fever in the city than there is in the country, but also that there is more of it there in proportion to the population. Typhoid fever must for the present, therefore, be regarded as an urban rather than a rural disease, at least in Massachusetts.

5. EVIDENCE DERIVED FROM THE VITAL STATISTICS OF THE STATE OF CONNECTICUT.

For comparison with Massachusetts we have next taken Connecticut, a state very similar in general and industrial character of population. The relative distribution of population between communities of smaller and larger sizes is somewhat but not very different in the two states, and here, as in Massachusetts, we have taken the "town" as our statistical community unit. We are fortunate also in having again the reliable vital statistics of a registration state upon which to make our researches.

Corresponding with what we have already done for Massachusetts, we have computed the following death-rates for certain groups of towns in Connecticut:

TYPHOID FEVER DEATH-RATES (PER 100,000 OF POPULATION) IN CONNECTICUT COMMUNITIES GROUPED ACCORDING TO POPULATION.
COMPUTED FROM THE CONNECTICUT STATE REGISTRATION REPORTS (1890-1907, INCLUSIVE).

POPULATION GROUP	NUMBER OF COM- MUNITIES	AVERAGE POPULA- TION 1890-1907	RATES BY YEARS																		Average Rate 18 Years
			1890*	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900*	1901	1902	1903	1904	1905	1906	1907	
Less than 500 persons.....	7	3,040	0	13	31	04	0	32	15	0	0	0	0	34	0	0	0	0	0	11.4	
500 to 1,000.....	37	27,100	42	35	21	43	50	25	15	7	10	10	10	11	15	11	10	10	20	16	22.4
1,000 to 1,500.....	24	31,200	34	51	35	40	28	16	25	19	20	23	24	14	16	13	10	9	12	12	22.4
1,500 to 2,000.....	18	28,500	50	33	34	27	33	20	11	4	14	9	26	13	14	4	14	21	12	12	19.5
2,000 to 3,000.....	24	57,100	19	36	27	37	30	21	14	11	15	14	37	15	13	8	13	14	24	20	20.4
3,000 to 4,000.....	17	65,300	34	29	29	27	40	31	22	11	16	15	21	15	7	7	5	12	12	10	19.6
4,000 to 5,000.....	7	32,000	54	53	40	34	26	10	16	22	19	13	25	15	25	28	13	11	20	11	26.4
5,000 to 8,000.....	12	77,800	30	47	39	36	35	23	31	25	10	31	34	14	29	8	15	18	15	24	25.7
8,000 to 10,000.....	4	35,800	12	52	86	31	29	27	22	15	15	17	62	16	7	20	30	23	20	11	27.5
10,000 to 15,000.....	6	61,200	47	40	50	26	12	37	22	7	22	21	32	12	15	9	10	25	12	17	23.6
15,000 to 25,000.....	6	117,600	57	39	36	38	26	46	23	15	16	12	25	25	32	34	13	23	10	33	28.4
25,000 to Bridgeport (67,700).....	4	169,600	55	34	36	28	19	20	24	20	22	16	26	25	25	22	17	17	17	20	24.6
Hartford (75,900) and New Haven (104,700).....	2	180,600	39	40	48	36	38	42	34	26	40	34	38	74	29	30	21	32	44	25	37.2
State.....	168	886,840	42	39	40	35	31	31	24	18	22	21	31	30	22	22	17	22	22	20	27.1

* Census years. Population for intervening years estimated by method of U.S. Census.

**RURAL VS. URBAN TYPHOID
IN CONNECTICUT**

1890-1907 INCL.
[SEE SUB-TITLE, CHART I]

TYPHOID DEATH RATE per 100,000 of Population

COMMUNITIES OF 500 TO 1000
COMMUNITIES OF 1000 TO 1500
COMMUNITIES OF 1500 TO 2000
COMMUNITIES OF 2000 TO 3000
COMMUNITIES OF 3000 TO 4000
COMMUNITIES OF 4000 TO 5000
COMMUNITIES OF 5000 TO 8000
COMMUNITIES OF 8000 TO 10,000
COMMUNITIES OF 10,000 TO 15,000
COMMUNITIES OF 15,000 TO 25,000
COMMUNITIES OF 25,000 TO 67,700 (BRIDGEPORT)
HARTFORD (75,900) AND NEW HAVEN (104,700)

Median Line for Dress
% for Quantity of Typhoid in State

BASES OF RECTANGLES REPRESENT AVERAGE AGGREGATE POPULATIONS IN EACH GROUP
HEIGHTS OF " " " " " TYPHOID DEATH RATES " " " " " ANNUAL DEATHS " " " " "

Scale of Bases of Rectangles

0 50,000 100,000 150,000 200,000
POPULATION

FIG. 4.

Surveying the Connecticut groups, we note the similarity of the distribution of typhoid fever here—whether measured by rates or by total deaths—with that in Massachusetts. The groups of communities of 1,500 to 2,000 and of 3,000 to 4,000 population show the minimum rates of about 19, and from that level the rates range to the group of the largest communities, embracing Hartford and New Haven, which group shows a rate of more than 37. In general also there is a progressive increase of rates from the smallest to the largest communities. If the total deaths, as indicated by

the areas of the rectangles, be taken into account, we find that the bulk of the deaths among communities of over 15,000 population much exceeds that among all the smaller, the median point for the areas (=deaths) falling between 15,000 and 25,000. The total deaths among the smallest communities—say under 3,000—is seen to be but a small proportion of the whole quantity of typhoid mortality.

For Connecticut we have also compiled the average annual death-rates from typhoid fever for each town and city for the 18 years under consideration and the results grouped in the order of such death-rates, from rate zero to rate 50 or more, are shown in detail in the following table:

AVERAGE ANNUAL TYPHOID FEVER DEATH-RATES PER 100,000 OF POPULATION IN CONNECTICUT COMMUNITIES, 1890-1907, INCLUSIVE. COMPILED FROM THE STATE REGISTRATION REPORTS.

Community	Average Population 1890-1907	Average Typhoid Fever Rate 1890-1907	Community	Average Population 1890-1907	Average Typhoid Fever Rate 1890-1907
TOWNS WITH NO DEATHS			Barkhamstead.....	900	10.8
Beacon Falls.....	465	0	Easton.....	967	11.5
Hartland.....	588	0	Middlefield.....	868	11.6
Lyme.....	784	0	Windsor Locks.....	3,015	11.7
Marlboro.....	361	0	Colchester.....	2,141	11.9
Salem.....	465	0	Essex.....	2,473	11.9
Total population...	2,663		Bolton.....	456	12.1
TOWNS WITH RATE 0-5			Warren.....	439	12.2
Preston.....	2,764	2.2	Goshen.....	855	12.3
Stratford.....	3,450	3.7	Chester.....	1,325	12.6
Total population...	6,214		Canterbury.....	888	12.6
TOWNS WITH RATE 5-10			East Windsor.....	3,118	12.6
Monroe.....	1,036	5.4	Salisbury.....	3,480	12.8
Sharon.....	2,007	5.6	Union.....	428	12.9
Coventry.....	1,668	6.4	Plainville.....	2,159	12.9
Willington.....	889	6.4	Suffield.....	3,467	12.9
Wilton.....	1,616	6.6	Old Lyme.....	1,201	13.0
East Haddam.....	2,502	6.6	Granby.....	1,202	13.0
Weston.....	830	6.8	North Branford.....	817	13.6
Canton.....	2,651	8.3	Litchfield.....	3,228	13.8
Newtown.....	3,316	8.4	Darien.....	2,903	13.9
Lebanon.....	1,543	8.7	Norfolk.....	1,603	13.9
Fairfield.....	4,395	8.6	Bridgeport.....	67,676	14.6
Harwinton.....	1,170	9.9	Griswold.....	3,434	14.7
Total population...	23,623		Saybrook.....	1,611	14.7
TOWNS AND CITIES WITH RATE 10-15			Cheshire.....	1,960	14.9
Pomfret.....	1,777	10.4	Total population...	116,820	
Wolcott.....	573	10.4	TOWNS AND CITIES WITH RATE 15-20		
East Haven.....	1,134	10.5	South Windsor.....	1,972	15.0
Bethany.....	522	10.8	Plainfield.....	4,785	15.0
			Wethersfield.....	2,582	15.3
			Ellington.....	1,785	15.6
			Newington.....	1,028	15.8
			Rocky Hill.....	1,032	15.9
			Guilford.....	2,784	16.0
			Milford.....	3,787	16.2
			Columbia.....	668	16.6
			Middlebury.....	710	16.7
			North Stonington.....	1,278	17.2
			New Milford.....	4,669	17.4

IS TYPHOID FEVER A "RURAL" DISEASE?

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VERAGE ANNUAL TYPHOID FEVER DEATH-RATES PER 100,000 OF POPULATION IN
CONNECTICUT COMMUNITIES, 1890-1907, INCLUSIVE. COMPILED FROM
THE STATE REGISTRATION REPORTS—*Continued.*

Community	Average Population 1890-1907	Average Annual Rate 1890-1907	Community	Average Population 1890-1907	Average Typhoid Fever Rate 1890-1907
Norwich.....	24,400	17.4	Kent.....	1,245	27.0
Torrington.....	11,492	17.5	Thomaston.....	3,282	27.0
Seymour.....	3,504	17.5	Plymouth.....	2,726	27.1
Bridgewater.....	644	17.7	Brookfield.....	1,037	27.4
Trumbull.....	1,567	17.8	Waterford.....	2,867	27.7
Colebrook.....	746	17.9	Orange.....	6,626	27.8
Berlin.....	3,321	17.9	Andover.....	387	28.1
Groton.....	5,898	17.9	Middletown.....	17,143	28.2
Burlington.....	1,232	18.2	New Britain.....	26,823	28.6
Canaan.....	843	18.2	Windsor.....	3,515	29.0
Southbury.....	1,216	18.3	Norwalk.....	19,593	29.2
Westbrook.....	882	18.3	Putnam.....	7,224	29.3
Avon.....	1,284	18.3	Manchester.....	10,245	29.3
Montville.....	2,387	18.7	Bethlehem.....	568	29.5
Vernon.....	8,531	18.8			
Woodbridge.....	864	19.2			
Meriden.....	28,176	19.4			
North Haven.....	2,119	19.9			
			Total population...	187,949	
Total population...	126,196				
TOWNS WITH RATE 20-25			TOWNS AND CITIES WITH RATE 30-40		
Franklin.....	551	20.2	Oxford.....	944	30.1
Greenwich.....	11,865	20.2	Old Saybrook.....	1,442	30.3
Prospect.....	535	20.3	Bozrah.....	830	31.1
Morris.....	542	20.3	Bloomfield.....	1,482	31.4
Woodbury.....	1,961	20.4	Clinton.....	1,421	31.5
Winchester.....	7,526	20.7	Danbury.....	19,474	31.7
Sprague.....	1,304	20.9	Enfield.....	6,774	31.9
Chatham.....	2,212	21.0	Somers.....	1,565	32.1
Chaplin.....	532	21.1	Haddam.....	2,027	32.5
Portland.....	4,009	21.1	Hebron.....	1,020	32.6
Mansfield.....	1,839	21.1	Branford.....	5,518	33.0
New Canaan.....	2,934	21.1	Woodstock.....	2,127	33.6
Thompson.....	6,311	21.2	Brooklyn.....	2,400	34.0
Tolland.....	1,036	21.4	North Canaan.....	1,786	34.9
Derby.....	7,635	21.7	Simsbury.....	2,060	35.3
Ashford.....	761	21.7	New Haven.....	104,730	35.4
Washington.....	1,792	21.7	Stamford.....	18,365	36.1
Madison.....	1,504	21.7	Ridgefield.....	2,567	36.3
Scotland.....	476	22.1	Bethel.....	3,338	39.5
Killingly.....	4,036	22.6			
Cornwall.....	1,191	23.2	Total population...	179,870	
Voluntown.....	900	23.2			
Farmington.....	4,272	23.7	TOWNS AND CITIES WITH RATE 40-50		
East Granby.....	678	24.1	Sterling.....	1,086	40.6
West Hartford.....	3,000	24.3	Hartford.....	75,857	40.8
Wallingford.....	8,639	24.5	Stafford.....	4,333	41.7
Glastonbury.....	4,140	24.8	Sherman.....	658	41.9
			Waterbury.....	48,448	42.1
Total population...	82,208		Bristol.....	9,304	43.1
			Eastford.....	529	43.4
TOWNS AND CITIES WITH RATE 25-30			Hampton.....	630	44.1
East Lyme.....	1,868	25.1	Killingworth.....	641	44.5
New London.....	16,980	25.1	East Hartford.....	6,113	45.5
Windham.....	10,132	25.3	Ledyard.....	1,228	46.1
Hamden.....	4,514	25.6	Watertown.....	2,983	46.1
Southington.....	5,832	25.8			
Lisbon.....	675	25.9	Total population...	151,810	
Huntington.....	5,334	26.3			
Westport.....	3,971	26.4	TOWNS WITH RATE OVER 50		
Stonington.....	8,326	26.4	Durham.....	880	50.8
Naugatuck.....	9,892	26.5	Cromwell.....	2,024	52.6
New Hartford.....	3,385	26.7	Roxbury.....	1,064	55.3
Redding.....	1,443	26.8	New Fairfield.....	596	72.6
Ansonia.....	12,331	26.8			
			Total population...	4,564	

Here again, as in Massachusetts, we find some of the smallest communities among those having the least typhoid fever mortality. If the word "rural" has any meaning, it is certainly applicable to many of these small communities in which the typhoid fever rate has over many years been exceedingly low. It is true that an equal number of communities of similarly small population may be found among those groups having higher death-rates. But while it is easy to account for this fact by the occasional importation of one or more cases, it is not easy, it is rather impossible, to account for the prolonged absence of the disease from purely rural communities if typhoid fever is in fact a rural disease, i.e., a disease of rural origin and rural habitat.

The quantitative relation of population to typhoid fever in Connecticut is well brought out in the following table from which it appears (in confirmation of the Massachusetts results given on p. 174) that the lowest rates occur in the smallest communities. So likewise do the highest rates; but while we have between rate 0 and rate 10 a population of 32,508 in communities under 5,000 population, we have at rate 50 and higher only 4,564 souls in communities of 3,000 or less. Again, while it is true that the largest groups of the more rural population (under 1,000) is between rate 10 and rate 15, the largest urban group is at rate 30-40. These figures surely do not indicate that typhoid fever is a rural disease.

CONNECTICUT COMMUNITIES ARRANGED BY POPULATION GROUPS AND ANNUAL TYPHOID FEVER DEATH-RATES FOR THE YEARS 1890-1907, INCLUSIVE.

TYPHOID DEATH-RATES AT OR BETWEEN	AVERAGE POPULATION OF COMMUNITIES, 1890-1907						
	Under 1,000	1,000- 2,000	2,000- 3,000	3,000- 5,000	5,000- 10,000	10,000- 25,000	Over 25,000
0.....	2,663	0	0	0	0	0	0
0-5.....	0	0	2,764	3,450	0	0	0
5-10.....	1,719	7,033	7,160	7,719	0	0	0
10-15.....	7,713	11,923	9,766	19,742	0	0	67,676
15-20.....	5,357	12,394	9,872	20,066	14,429	35,932	28,176
20-25.....	4,975	10,727	5,146	19,484	30,111	11,865	0
25-30.....	1,630	5,593	5,593	18,682	43,234	86,394	26,823
30-40.....	1,774	8,176	11,181	3,388	12,292	37,839	104,730
40-50.....	2,458	2,314	2,983	4,332	15,417	0	124,305
Over 50.....	1,476	1,064	2,024	0	0	0	0
Totals.....	29,465	59,664	56,489	96,806	115,483	172,030	351,710

It will be remembered that the Massachusetts results indicated that previous to 1890 typhoid fever was far more truly than since that time "a rural disease" (p. 165). The following table reveals

the same fact for Connecticut communities and proves beyond peradventure that an astonishing change in urban and rural typhoid has occurred since about 1882. This table should first be studied by itself and then its last column (of 8-year averages) should be compared with the data for 1890-1907 on the table previously given:

TYPHOID FEVER DEATH-RATES (PER 100,000 OF POPULATION) IN CONNECTICUT COMMUNITIES GROUPED ACCORDING TO POPULATION. COMPUTED FROM THE CONNECTICUT STATE REGISTRATION REPORTS, 1882-1889, INCLUSIVE.

POPULATION GROUP	AVERAGE POPULATION 1882-1889	RATES BY YEARS								Average Rate, 8 Years
		1882	1883	1884	1885	1886	1887	1888	1889	
Under 500 persons...	2,549	44.6	0	79.5	36.0	350.7	0	44.3	93.0	81.0
500 to 1,000.....	25,390	71.7	52.5	45.9	16.9	46.3	35.0	41.6	44.2	44.3
1,000 to 1,500.....	37,774	58.5	50.1	20.4	46.3	26.2	27.4	43.7	34.9	38.4
1,500 to 2,000.....	35,516	35.5	40.0	44.7	56.5	61.4	20.5	37.4	49.6	43.2
2,000 to 3,000.....	61,938	50.0	37.1	28.3	22.6	25.5	23.7	43.3	35.3	33.2
3,000 to 4,000.....	62,605	43.4	41.1	28.6	31.4	37.1	17.9	51.1	47.3	37.2
4,000 to 5,000.....	23,355	187.8	59.0	73.9	22.2	35.1	42.4	56.7	37.1	64.3
5,000 to 8,000.....	78,656	56.3	39.1	41.1	33.1	40.1	32.0	50.9	40.9	41.9
8,000 to 10,000.....	23,533	29.5	92.2	40.5	66.1	30.1	36.8	43.2	27.5	45.7
10,000 to 15,000.....	57,031	35.1	28.1	25.6	14.7	14.6	23.1	18.9	21.2	22.4
15,000 to 25,000.....	95,630	53.0	72.3	37.7	32.7	31.9	25.9	23.5	46.7	40.5
25,000 to Bridgeport..	61,413	27.2	5.7	49.7	38.1	27.5	34.7	27.9	24.2	29.4
Hartford and New Haven.....	124,696	47.9	38.5	58.2	30.8	36.4	24.7	48.2	37.0	40.2
The state.....	690,086	49.6	44.0	40.7	32.5	34.6	27.1	40.4	38.3	38.4

Population calculated from U.S. Census figures.

Grouping the Connecticut communities according to their typhoid death-rates for the period 1882-89, brings out clearly the excessive incidence of typhoid fever in the towns below 5,000 population. A comparison of this table with the corresponding one for 1890-1907 shows a relatively greater decrease in typhoid fever mortality during the later period of our study for towns below 5,000 population than for the more urban communities above 5,000. In the group comprising the largest cities (over 25,000) a majority of the population was above "rate 30" in both periods. In the next two groups (5,000-10,000 and 10,000-25,000) a majority of the population was above "rate 30" in the earlier period and above "rate 25" in the later. More than half of the population of the groups below 5,000 was above "rate 30" for 1882-89 but the dividing rate had dropped to "rate 20" in 1890-1907. It appears then that in the 25 years under consideration the typhoid fever mortality

of the large cities of Connecticut has remained nearly constant, but that since about 1890 there has been a slight decrease in the typhoid rates of the communities of middle size and a considerable decrease in typhoid rates in the small towns.

CONNECTICUT COMMUNITIES ARRANGED BY POPULATION GROUPS AND TYPHOID FEVER DEATH-RATES (PER 100,000) FOR THE YEARS 1882-1889, INCLUSIVE.

TYPHOID DEATH-RATES AT OR BETWEEN	AVERAGE POPULATION OF COMMUNITIES, 1882-1889						
	Under 1,000	1,000- 2,000	2,000- 3,000	3,000- 5,000	5,000- 10,000	10,000- 25,000	Over 25,000
0.....	4,256	2,817	4,586		0	0	0
0-10.....	0	1,394	0	0	0	0	0
10-15.....	0	4,907	9,927	3,352	0	13,642	0
15-20.....	3,784	4,383	4,767	3,998	13,144	28,203	0
20-25.....	2,651	2,873	7,554	11,169	23,416	0	39,883
25-30.....	1,884	2,324	13,131	10,474	9,124	13,719	0
30-40.....	942	25,012	7,426	18,070	7,000	58,540	76,521
40-50.....	4,264	11,847	2,225	10,642	5,729	32,202	47,925
50-75.....	4,321	9,932	9,725	26,004	29,863	0	27,383
75-100.....	2,990	4,540	0	4,546	5,343	0	0
Over 100.....	2,319	1,538	2,410	0	6,978	0	0
Totals.....	27,417	71,627	61,751	88,265	100,597	146,306	191,712

6. EVIDENCE DERIVED FROM THE VITAL STATISTICS OF THE STATE OF NEW HAMPSHIRE.

Lastly we have carefully considered the vital statistics of the state of New Hampshire, comprising a number of communities closely similar in many respects to those of the contiguous state of Massachusetts and therefore not very different from those of the nearby state of Connecticut, but having a much larger proportion of its population scattered over a large area in smaller communities. There is also considerable difference in the economic and industrial conditions of New Hampshire communities, since manufacturing, which is so prominent in Massachusetts and Connecticut, plays a distinctly less important part in New Hampshire. All this means that New Hampshire is, on the whole, a more rural state than either of the others and that it has more of its population living under strictly rural, i.e., country, conditions. The population of New Hampshire, smaller than that of Massachusetts, is distributed over a slightly greater area, and is, accordingly, a sparser and less concentrated population.

In the following table we present certain vital statistics of New Hampshire arranged in a form similar to that employed above for the states of Massachusetts and Connecticut, and fortunately also, like these, based upon trustworthy registration reports:

YPHOID FEVER DEATH-RATES (PER 100,000 OF POPULATION) IN NEW HAMPSHIRE COMMUNITIES GROUPED ACCORDING TO POPULATION. COMPUTED FROM THE NEW HAMPSHIRE STATE REGISTRATION REPORTS, 1890-1907, INCLUSIVE.

POPULATION GROUP	NUMBER OF COMMUNITIES	AVERAGE POPULATION 1890-1907	RATES BY YEARS																Average Rate, 18 Years
			1890*	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900*	1901	1902	1903	1904	1905	
			1890*	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900*	1901	1902	1903	1904	1905	
Less than 500 persons.....	51	15,520	35	18	36	18	30	68	31	6	13	13	20	27	..	7	35	7	21.8
500 to 1,000.....	81	57,810	27	49	27	22	39	15	29	10	16	21	24	16	14	18	11	5	20.2
1,000 to 1,500.....	43	51,790	37	17	17	17	17	10	27	10	21	23	19	15	13	19	21	13	17.6
1,500 to 2,000.....	24	41,130	40	58	40	22	37	20	25	20	19	19	36	34	17	12	19	21	26.2
2,000 to 3,000.....	13	31,430	25	25	13	16	38	10	13	13	25	10	3	16	22	29	..	6	16.5
3,000 to 4,000.....	7	23,760	58	57	51	64	18	4	31	22	38	54	41	12	20	55	16	4	33.0
4,000 to 5,000.....	2	9,610	12	36	36	..	68	22	33	54	11	10	40	..	20	10	..	19	21.6
5,000 to 8,000.....	3	18,840	63	28	48	59	17	11	39	11	27	16	5	20	30	15	43	14	18
8,000 to 10,000.....	3	26,080	18	22	12	36	36	20	35	27	15	4	11	19	19	15	15	18	20.3
10,000 to 15,000.....	2	23,660	33	22	31	26	17	17	13	13	25	17	25	29	29	25	12	25	22.5
15,000 to 25,000.....	2	37,450	30	54	24	18	23	33	32	12	21	9	5	11	13	13	15	11	18
Manchester.....	1	55,060	34	42	11	29	47	41	39	23	26	20	16	15	13	15	21	17	23.7
The state.....	232†	397,110	33.9	37.9	25.7	26.0	31.8	21.7	28.7	16.0	21.7	18.5	19.4	18.1	16.7	19.0	16.9	13.2	21.8

* Census years. Populations for intervening years estimated by method of U. S. Census.

† Two towns are omitted on account of changes in incorporation; also certain unincorporated places; total population thus omitted, 4,970.

3,000 population. This finding is quite different from that in Massachusetts and Connecticut, as will readily appear by comparing the median lines for those states with that for New Hampshire. At the same time the greater proportion of population in the smaller and more rural communities in the case of New Hampshire must not be overlooked. In New Hampshire, apparently, typhoid fever cannot be said to prevail to any decidedly greater extent in either group, rural or urban.

The fact that it appears to have been relatively abundant in communities of medium size, as noted above, is precisely what theory would lead us to expect in a state of this kind. We should not expect to find typhoid fever abundant in strictly rural districts of very small population and consisting chiefly of scattered farm-houses. Neither, on the other hand, should we expect to find it abundant in cities like Manchester, Concord, and Nashua, which are well known to have water-supplies of excellent quality and boards of health of good repute. We should rather look for it exactly where we find it most prevalent, namely in places which are neither strictly rural nor strictly urban, where people are perhaps gathered closely together, but as yet without the advantages of strictly urban conditions. In such places, as we have repeatedly intimated, modern conveniences, such as public water-supplies and sewerage systems, have often not yet come, although they are greatly needed, while the conditions are those of aggregation rather than segregation and carriers as well as unfavorable sanitary conditions naturally make for the prevalence of typhoid fever.

7. RECAPITULATION AND CONCLUSIONS.

In the first section of the present paper we have drawn attention to the discrepancy which appears to us to exist between the logical corollaries of our modern knowledge of the origin and distribution of typhoid fever on the one hand, and prevalent opinion concerning the relative frequency of typhoid fever under urban and rural conditions on the other.

In the second section we have cited at considerable length various authors, some of whom assert that typhoid fever is a rural

disease and others of whom appear to be equally confident that it is an urban rather than a rural disease.

In the third section we have discussed at some length the terms "urban" and "rural" in order to obtain a sound basis for such investigations as appear to us to be required.

In the fourth section we have described in detail a very careful and, as we believe, a thorough statistical investigation of the actual facts concerning the distribution of typhoid fever mortality in country and city in the state of Massachusetts; and in the two following sections, similar studies of the vital statistics of the contiguous states of Connecticut and New Hampshire.

It now only remains to bring together what we conceive to be the results of all these studies and to draw from them such deductions as are justified.

The first and most important conclusion to which our investigations lead is, that if we take as long a period as 18 years previous to 1908, typhoid fever cannot be said to be in any real and true sense of the word distinctly a rural disease, that is to say, pre-eminently a disease of small communities composed of isolated or scattered dwellings distributed over country districts.

A second and perhaps equally important result is that this general finding, while it holds good for the period 1890-1907, is not true if we consider only the preceding decades. In other words, about 1890 a remarkable change appears to have taken place in the incidence of typhoid fever mortality—at least in Massachusetts and in Connecticut—such that whereas previous to that time typhoid fever deaths were more prevalent in proportion to the population in the country than in the city districts, after that time and measured in that way typhoid fever became distinctly a more urban than rural disease. For this discovery we were in no wise prepared when we began our studies and we are the more gratified to have developed the fact because it enables us to harmonize what would otherwise have been our discordant results with the studies and statements of earlier authors.

It is not easy to account for this change, and we might perhaps better leave our results as they stand, without trying to explain them. Piqued by curiosity, we have, however, sought to find some

explanation of them, first, for the fact—for it appears to be a fact—that previous to 1890 typhoid fever in Massachusetts and Connecticut evidently was a rural rather than an urban disease, second, for the change which then took place, and, third, for the present state of affairs in which typhoid fever (in Massachusetts and Connecticut at least) appears to be an urban rather than a rural disease.

It is hard today to see why typhoid fever should ever be, or ever have been, more abundant in country than in city. The very fact of segregation of population tends to make infection difficult, and without infection there can be no typhoid fever. It was this *a priori* reasoning which originally led us to undertake the present investigation, for this view is opposed *in toto* to the popular belief that typhoid fever is a rural disease, and, as we have stated at the beginning of this paper, it was this contradiction between rational theory and traditional opinion which caused us to set to work to discover the truth.

We know that before 1890 typhoid fever in Massachusetts and Connecticut was apparently more a rural than an urban disease, not only from the studies reported in the present paper but also from the investigations of Dr. Abbott and Dr. Derby. The question arises (1) Why was this the case? And also, (2) What conditions of *infection*, *virulence of microbes*, or *vital resistance* (the three factors of any infectious disease) prevailed before the year 1890 or thereabouts which were afterward so altered as to reverse the incidence of the disease?

There is no good reason to assume for the years previous to 1890, any greater virulence of typhoid microbes in the country than in the city, or any greater vital resistance in the city than in the country, nor is there any reason for assuming any change in relative virulence or relative resistance since that time. The only possibility that has even a shadow of reasonableness is that somehow the relative conditions of infection have changed. But if so, how? There is one possible explanation which, though not wholly satisfactory, is worthy of note:

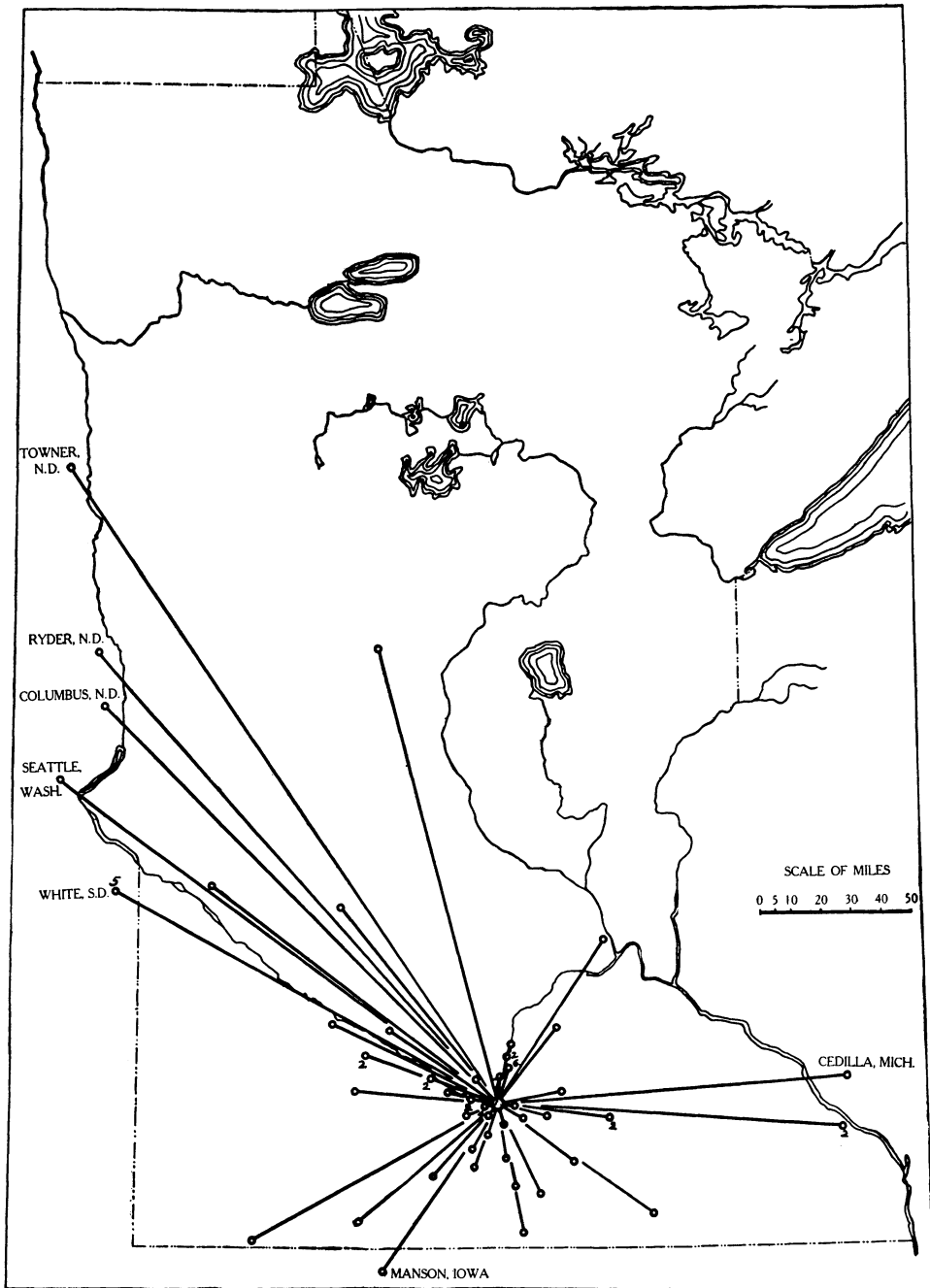
The Civil War of 1861-65 caused the germs of typhoid fever to be carried as never before or since into many a rural home

and many a rural hamlet. Some, perhaps many, of those who came back from the war worn and weakened were doubtless "typhoid carriers," and some doubtless long remained such. It is possible that the infection thus widely planted continued to be felt during the 30 years between 1861 and 1891, but by the latter date had become mostly attenuated or extinct. If this were true we should only have to explain the relatively higher mortality in the rural regions during the period. And this might be done by supposing (what was doubtless true) that various rural conditions, such as more frequent failure to recognize or attend to the disease, less skilful diagnosis, or nursing, or medical attendance, or more contacts *within families*, etc., existed in the more rural districts.

Assuming the truth of this hypothesis of lingering military or camp infection from the Civil War, it is comparatively easy to account for all the facts. The presence of high typhoid rates in the country districts during the periods studied by Drs. Derby and Abbott—a condition normally impossible—would be due to the return of infected soldiers. The same cause should also produce at the same time high typhoid rates in cities, but some difference in favor of a lower rate in the cities might have been due to early diagnosis, better care, hospital treatment, etc. The gradual decline in both urban and rural typhoid rates might be due in part to the gradual exhaustion of the original infection. A more rapid decline in the country than in the city might be expected to occur because of the comparative isolation of the patients and the absence of opportunities for contact infection outside infected families or houses.

On this theory also we have an explanation in whole or in part of the origin of the high typhoid fever death-rate which has long been a reproach to the entire United States. The prolonged persistence of that high rate, however, could hardly be due wholly to such original infection. Other factors, such as polluted water, polluted milk, promiscuity, etc., must be called in to explain such persistence, and these would be much more likely to be effective under urban than under rural conditions.

The effect of certain other great movements of the population during the period covered by our study deserves careful consideration, namely, *immigration* and *urbanization*, or the growth of cities more or less at the expense of the country.



Map of Minnesota showing the position of Mankato and how typhoid cases were radiated from it during the epidemic.

It is probably true that during the period under consideration immigration of Europeans free from typhoid fever was directed largely to the more urban portions of New England, and this was probably especially true during the earlier period, which would only tend to bring out more clearly the phenomenon of typhoid fever excess in the rural districts. In the later years of the period more of this typhoid-free population has perhaps gone to the country and may thus have helped to accentuate that decline in rural typhoid which we have repeatedly noted. Obviously, the general effect of such immigration would be to dilute the population with typhoid-free material and thus help to lower the general rate. It is, however, quite impossible to be certain how far the inflow of immigrants from Europe has influenced, if at all, the American death-rate from typhoid fever.

The other great movement, from the country districts into the cities, has been equally marked and very likely equally influential. But here also it is impossible to say precisely what the effect of this movement upon typhoid fever incidence and mortality may have been.

It will doubtless appear strange and incredible to many not only that typhoid fever is today an urban rather than a rural disease, but also that it is quite as often spread from town to country as from rural to urban districts. We are therefore glad to be able to refer for an illustration and a striking example to the epidemic of 1908 at Mankato, Minn., first described by Professor F. H. Bass in the *Engineering News* of February 11, 1909 (61, p. 151).

In the Mankato epidemic, which was due to polluted water, 72 cases with five deaths were found in the surrounding country which had derived their infection from the polluted water-supply of Mankato. A diagram of some of these was originally published by Professor Bass (*op. cit.*) in which the sites of the cases are connected with Mankato by lines radiating from the city as a center to the various rural points, some near and some very remote, where the cases occurred. The diagram is so striking and so instructive that we have ventured to reproduce it here. A complete account of the epidemic and another map appeared in this *Journal* for 1911, 9, p. 422, Fig. 6.